

D. B. Dowling, Photo.

CAT HEAD—LAKE WINNIPEG.

GEOLOGICAL SURVEY OF CANADA

G. M. DAWSON, C.M.G., LL.D., F.R.S., DIRECTOR

REPORT

ON THE

GEOLOGY OF THE WEST SHORE AND ISLANDS

OF

LAKE WINNIPEG

BY

D. B. DOWLING, B.A.Sc.



OTTAWA

PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST
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To G. M. DAWSON, C.M.G., LL.D., F.R.S.,
Director Geological Survey of Canada.

SIR,—I beg to submit the accompanying report on the west shore and islands of Lake Winnipeg. In order to complete the descriptions of occurrences of all the formations in this district, extracts are taken from Mr. J. B. Tyrrell's notes. To illustrate some of the structural features sketches and sections are also submitted.

I have the honour to be, Sir,
Your obedient servant,

D. B. DOWLING.

JANUARY, 1899.

NOTE.—*The bearings in this report are all referred to the true meridian*

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REPORT
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GEOLOGY OF THE WEST SHORE AND ISLANDS OF LAKE WINNIPEG

By D. B. DOWLING.

GENERAL DESCRIPTION.

The basin in which Lake Winnipeg lies is very long and rather shallow, divided by narrows into two parts, the major portion being that to the north. The lake ranks fifth in superficial area among the lakes of North America. Its area of 9,414 square miles is 2,150 square miles more than that of Lake Ontario, and but 500 square miles less than that of Lake Erie. Its greatest length is 260 miles, somewhat longer than Lake Erie, or about the distance from Ottawa to Hamilton, Ont. For the sake of comparison it may be interesting to note that this is also nearly the length of the peninsula of Nova Scotia from the Strait of Canso to Yarmouth or only twenty miles less than the length of Vancouver Island. In width the lake varies very much, as a reference to the accompanying map will show, but its maximum, in the northern part, is about sixty-six miles. It has a mean height above the sea of 710 feet, and a general depth of from 40 to 60 feet. The fact that the lake is so shallow is no doubt mainly due to the shape of the rocky basin in which it lies, but it has been still further reduced by the amount of silt deposited already by its waters. This lake is the principal settling basin at present for the waters of streams draining from the Rocky Mountains, as well as those coming from the south by the valley of the Red River, and the streams from the eastern side from the height-of-land to Lake Superior.

On the east side, the principal streams entering the lake are :—The Winnipeg River, the Berens River, the Pigeon, Poplar, Manigotagan and several smaller streams. These flow from the country underlain by the Archaean.

On the south, the continuation of the depression in which the southern portion of the lake lies is that down which the Red River drains, bringing with it the waters of the Assiniboine, Pembina and other tributaries. On the west, the greatest stream entering the basin is the Saskatchewan. This large river literally falls into Lake Winnipeg, as in the last four miles of its course the descent is 70 feet, forming the Grand Rapids. The Dauphin or Little Saskatchewan River drains into Sturgeon Bay and brings the surplus from Lakes Manitoba and Winnipegosis.

Other small streams such as War-path River, Fisher River and Icelandic River may be mentioned, but they drain only limited areas.

Geological Features.

Formation of
basin.

The basin of Lake Winnipeg is excavated along the contact of the Palaeozoic limestones with the Archaean which forms so large a part of the middle northern part of the continent. Here the surface of the Archaean forms a gently sloping plain trending to the south-west, on which was laid down a very sandy deposit, first formed when the sea was advancing, followed by a succession of limestone beds. The thinner overlapping deposits have now been removed from the Archaean, and the process of denudation has been no doubt greatly assisted by the scouring action of the glaciers, until what was, perhaps, previous to glacial times, an escarpment along the foot of which ran a stream passing probably through several small lakes, is now a large basin occupied by the lake, on the western side of which are found the cliffs of limestone that are the remains of beds that formerly extended north-eastward to join those of the Hudson Bay basin. The rocks of the east shore are all gneisses, granites, schists, &c., of the Laurentian and Huronian formations, and the country is naturally more rocky and barren than that to the west and south, which is well covered by till or boulder-clay and later lacustral deposits. From Lake Winnipeg eastward, there is, partly covering the rough rocky country, a deposit of stratified clay and silt which has been carried to a height of about one hundred and fifty feet above the present lake during one of its higher stages, while still ice-dammed to the east. The silt deposited in this way was derived from the material brought by the glacier and is found to extend northward past the limits of the map, affording farming land in unexpected quarters where only rocky hummocks would otherwise be looked for. In this connection the following paragraph by J. B. Tyrrell may be quoted:—

Lacustral
deposit of
east side.

'A deposit of clay similar to that on Mossy Point extends all along the east shore of Lake Winnipeg, and the waves dashing against the soft cliffs become charged with the mud, from which the lake derives its name. This clay is also of great economic interest, for instead of the east shore of the lake being an uninhabitable rocky wilderness, as is generally supposed, it is largely covered with a rich, blue alluvial soil, and the area of rock surface is relatively small. Much of this land is covered with forests of poplar and spruce, while on account of the retentive impervious nature of the clay soil much of it is also boggy and wet, but when it is cleared and drained it will form rich agricultural lands. At Badthroat River, Mr. Wood, the local Inspector of Fisheries, had cleared a beautiful farm out of the midst of the poplar forest, and he informs me that he grows successfully all the crops ordinarily raised in Ontario. Mr. McKay, the Indian Agent at Berens River, has also a clearing situated on the south side of the river in the midst of what was a dense forest of small spruce. He has under cultivation a nice garden, and this year the potatoes were not cut down by the frost till the middle of September.*

Agricultural land.

On the south side, the limestones are generally deeply covered by a mantle of boulder-clay. The lacustral deposits of the glacial Lake Agassiz are thinner here than to the south. Those along the east side, near the Winnipeg River, are sandy, and the rich, black alluvium of the valley of the Red River is confined to narrow limits. Those near the lake are generally later river deposits brought down by the present stream.

Soil of south side.

Along the west shore, the rock exposures show sandstones capped by Trenton limestones, and many picturesque headlands rise in steep cliffs of a light-yellowish and whitish limestone lying in horizontal beds. The surface of the country behind is of a general level aspect, rising slightly. Over all this is a mantle of boulder-clay, mostly of a reassorted character, showing faint lines of stratification as though deposited in a body of water. Traces of underlying drift deposits which have been overridden by the glacier are occasionally suggested by the form of some of the smaller low-lying islands near the west shore whose contour and outline have the aspect of drumlins. The surface is generally well wooded with aspen (*Populus tremuloides*) and black and white spruce (*Picea nigra* and *P. alba*).

Rocks and soil off west shore.

The principal settlements are those of the Icelandic colonies on the west side of the southern portion of the lake, those of the Indians and

* Annual Report, Geol. Surv. Can., vol. V. (N.S.) 1890, p. 32 A.

half-breeds on the lower part of the Red River and scattered settlements on the east side, principally between the Red River and Fort Alexander. The accompanying map also shows in its southerly part the more thickly populated country in the vicinity of the railway lines.

General Resources.

Fishing
industry.

Fishing.—The waters of the lakes in the basin are generally well stocked with a large variety of the fresh-water food fishes, but the abundance of these in the waters of Lake Winnipeg has induced the establishment of extensive fisheries and the curing and shipment of large quantities of whitefish and trout. From the reports of the Inspector of Fisheries for this district the following figures are submitted.

The fish exported in the early years of the industry were whitefish, pike and pickerel, and for the years 1883 and 1884, the figures are given as follows :—

| | 1883. | | 1884. | |
|----------------|-------------|---------|--------------|----------|
| | Quantity. | Value. | Quantity. | Value. |
| Whitefish..... | 72,867 lbs. | 8 3,041 | 359,000 lbs. | 8 14,036 |
| Pike | 51,850 " | 1,061 | 561,000 " | 13,855 |
| Pickerel..... | 2,400 " | 480 | " | |
| | 127,117 " | 8 4,582 | 920,833 " | 8 27,891 |

Export for
1883-84.

These figures represent the export for the province, but as the principal fishing was in the large lakes of Manitoba, that for Lake Winnipeg must have been fully one half. This great increase in the export between the above years is probably accounted for by the formation of fishing companies that erected large ice-houses at Selkirk and Westbourne near Lake Manitoba. During the next year the increase was 100 per cent and for 1885 the figures given are as below :—

| | Quantity. | Value. |
|-----------------|--------------|----------|
| Whitefish | 759,730 lbs. | 8 32,500 |
| Pike..... | 670,443 " | 21,877 |
| Pickerel..... | 33,515 " | 1,340 |
| Tullipee | 1,600 " | 80 |
| | 1,465,288 " | 8 55,797 |

Export for
1885.

The product of Lake Winnipeg is fully half of the total, as an estimate of the winter fishing and other shipments from Lake Manitoba

is given as :—whitefish 300,000 lbs., pike 450,000 lbs. The growth of the industry may be further studied by referring to the figures for the years 1888-89-90 during which three fishing companies were operating on Lake Winnipeg, employing many tugs and barges for the conveyance of frozen fish to the cold-storage warehouse in Selkirk. The fish at that time were frozen while freshly caught, by means of salt and ice. In 1889 these companies employed about sixty miles of nets.

Value of export of fish :—

| | | |
|-----------|-----------|------------|
| 1888..... | \$180,677 | Export for |
| 1889..... | 167,670 | 1888-1890. |
| 1890..... | 232,104 | |

The decrease in 1889 from that of 1888 is due to the decrease in the quantity of salted whitefish shipped, the industry having been altogether discontinued in favour of the frozen fish. The output of the smaller lakes was maintained at about the same figures for nearly all these years, the estimate for 1889 being about \$21,000. It is thus evident that the fishing industry of Lake Winnipeg is very important. Subsequently a fish-hatchery was established at Selkirk, and as a means of self-protection from over production and possibly depletion of the lakes, the companies became amalgamated into one concern, using more modern methods in preserving and shipping. At present the cold-storage warehouse in Selkirk is equipped for the ammonia process, and several large steamers are constantly running during the fishing season to the fishing grounds, principally in the northern part of the lake, where there are branch establishments at Selkirk Island, Mossy Point and at Berens Island.

Timber.—On the western shores there doubtless remain isolated patches of large white spruce, but many areas have been practically exhausted. Small portable mills were erected at convenient points and all the available material in the vicinity was sawn up. Then the mills would be moved to other grounds. Such points may be mentioned as Fisher River and Fisher Bay, Washow Bay and the vicinity of Dog Head, west side. On the east side of the lake, the streams operated on generally afforded sufficient water-power to run the mills, but in a few cases, steam was also used. The principal lumbering operations on the east side have been on the Bad-throat River and possibly other streams will be exploited. The best timber reported on this side is on the Gunisao River flowing into the channel between Great and Little Playgreen lakes.

From the report of the Crown Timber Agent, the following figures are given as the amount of lumber (spruce) cut at the following places:—

| | Ft. B.M. | Ft. B.M. | Ft. B.M. |
|--------------------------------------|-----------|-----------|-----------|
| | 1889. | 1890. | 1891. |
| Badthreot River (two companies)..... | 1,737,284 | 1,662,241 | 1,724,159 |
| Fisher Bay..... | 2,401,582 | 1,350,000 | 800,000 |
| Ebb and Flow Bay..... | 795,750 | 1,204,698 | 1,047,475 |
| Washow Bay..... | 251,553 | | |
| Fisher River..... | 1,658,232 | | |
| Grindstone Point..... | | 98,000 | |
| Black Island..... | | | 516,490 |
| | 6,844,401 | 4,314,939 | 4,088,124 |

This return shows a steady decrease and compared with that for 1884 maintains about the same ratio, the returns for 1884 being 7,820,000 ft. B. M.

Economic
Minerals.

Minerals.—As the greater portion of the area surrounding the lake is underlain by Laurentian gneisses and Palæozoic limestones, the districts in which the precious metals might be looked for are very limited, and are confined to the two areas of Huronian indicated on the map. In that shown near Wannipegow River, many claims have been staked, and a small amount of development work has been carried on, but returns as to the assays of ore are not to hand. Gold and silver ores are reported, but apparently they are of small amount.

Molybdenite—Small masses of this mineral are reported by Mr. Tyrrell from granite veins on Little Playgreen Lake.

Iron ore—A deposit in apparently large quantities is found on Black Island, and this will no doubt be again exploited.

Gypsum—Deposits of workable extent are known to exist north of Lake St. Martin, but the needs of the province have not yet called for their being worked.

Building
stone.

Building Stone.—The quarries at Selkirk produce a soft mottled limestone of excellent texture, and those at Stonewall and Stony Mountain have been already worked to a large extent. The exposures on Lake Winnipeg, mainly those of the lower and middle beds of the Trenton, are of beds too easily split into thin slabs to be useful for large building operations, so that the building stone is confined to the upper beds which are exposed mainly in the southern part near the settlements.

Lime.—Almost any of the limestones of the district produce a good Lime. lime. That from Stonewall is, however, of a fine white colour and is much more in demand for finishing work than that from the lower beds. Kilns were erected at one time at Grindstone Point for the manufacture of lime, but the carriage on the lake was attended by so much difficulty as to discourage the industry.

Clays.—Pottery clay or clay for fine terra-cotta could no doubt be Clays. found at many places along the east shore of Lake Winnipeg, but the only deposit known to be worked is in the vicinity of Lac du Bonnet. The resultant terra-cotta is of a dark-brown colour. Brick-clays in the vicinity of Winnipeg, and in fact in all the southern part of the province, produce a light cream-coloured brick which is much employed. This clay by a much more thorough burning would in some cases become red, but the result would perhaps not warrant the added expense.

The natural resources of the district may still be said to include the game and fur-bearing animals, though these are fast being depleted as settlement encroaches on the wilderness. The country on the east and to the north still produces many bales of furs for the trader. The natural water-powers of the Winnipeg River, which are within reasonable distance of the city of Winnipeg, should in the near future become of great importance for electrical power and light. All the streams on the east side also have many eligible sites for water-powers and even on the Saskatchewan, the great fall at the Grand Rapids may be some day utilized. Water-power.

Navigation of the Lake.

The great length of the lake, running as it does nearly north-and south, would suggest at once a long navigable stretch leading toward the tide-waters of Hudson Bay, and many years ago surveys were carried out for a railway from the lake to York Factory. At present the principal carrying trade of the lake is connected with the fishing industry, the lumbering and the mercantile supplies of the fur-trading posts situated in its vicinity and along the waters of Nelson and Saskatchewan rivers. Previous to the building of the railway lines to Edmonton and Prince Albert on the Saskatchewan, large shipments were made up this river in flat-bottomed river steamers, as often as the state of the water would admit, and a small tramway was built across the bend from the foot to the head of the Grand Rapids. Navigation of lake.

Navigation of lake.

The shallow nature of the lake renders it a very difficult one to traverse in many parts,—shoals occur in localities far from land—the suspended matter in the water prevents shallow spots from being recognized, and, for small boats, the storms raise in a short time a very heavy sea. As the accompanying map is the first published from instrumental surveys, it may have to be used as a chart by some of the masters of the boats sailing on the lake. It may be mentioned that courses may be taken from the magnetic meridian laid down at the north-west corner, bearing in mind the fact that the variation is decreasing slightly to the south, and at the mouth of Red River is only 14° E. This decrease is hardly appreciable on the ordinary marine compass card. The soundings marked are in feet and are indicated only where actually taken.

Variation of compass.

Notes on the depth of Water and Sailing Courses at various Points.

Notes on depth of lake.

In the southern portion of the lake, below Big Island, the map contains indications of all the shoals noted. The general depth of the water is about 30 feet, but between Big Island and Black Island the channel has been scoured out by the currents to a depth of over 40 feet. A light has been established on the narrow point to the east of Gull Harbour.

Gull Harbour is merely a large bay opening to the north-east. It is a good shelter from the south and north-west.

Grassy Narrows is becoming silted up, so that it is available only for small boats.

Gull Harbour to Grindstone Point.

The water in the channel from Gull Harbour to Grindstone Point, by the west end of Punk Island, is all of good depth at moderate distances from the points. Off Grindstone Point the depth is about 50 feet close to the point and shoals gradually to the eastward. The east shore is flanked by many reefs and the channel to the east of Punk Island is dangerous, unless buoyed.

To Bull Head.

From Grindstone Point to Bull Head there is good water in the direct course. As for shelters in this part of the lake, exclusive of the east shore, the bays on the north and south side of Berry Island can be used, as there is apparently good water near the shore. Shoals may be found between the island and Anderson Point, but another small bay three miles west of Grindstone Point is large enough to shelter boats drawing less than 10 feet of water. Small fishing boats can in medium high water be taken in behind a hook or gravel spit projecting from the east side.

From Bull Head to Dog Head the shores are all steep, and there is good water to near the shore, while there are several sheltered points that would do well for boat landings. Just inside the point at Bull Head there is a wharf for the steamers to wood up at, but this is somewhat exposed to the north.

Bull Head.

In the narrows at Dog Head, following a change of wind, a very strong current is started. This often raises a heavy sea for small boats. On Black Bear Island there is a good harbour at the centre of the south side, and is a deep cut nearly through to the north side. The eastern end of this island is a limestone cliff, thirty feet high, on which is established a light. The water off this cliff is said to be very deep, but we found only about 40 feet. In the channel at Dog Head the deepest point was 96 feet near the west shore. This is the deepest we found on the whole lake. The channel to Fisher Bay on the east side of Moose Island is narrow, and at the narrowest part a shoal was struck near the centre of the opening, on which there was only 5 feet of water. Fisher Bay is not much deeper than 14 feet in any part.

The Narrows
at Dog Head.

Fisher Bay.

At the south end of Little Tamarack Island there is a gravel spit behind which fishing boats can shelter. For storms from the east there are several shelters along the east shore, and a good harbour at Rabbit Point, but it was not visited by the writer.

Little
Tamarack
Island.

The western channel from Dog Head to Stony Point, passing Jack Head Island, is much too shallow to be safe for steamers without a pilot knowing of the location of the shoals to the north of Egg Islands.

A gravel bar that is likely to prove dangerous to navigation is situated to the west of Flour Point. It is about five and a half miles from the east shore, and steamers running between Dog Head and Berens Island should not get out of their course to the west or not more than four miles from Flour Point. During low water and in daylight it can be seen as a white bar, but its position, so far out in the lake, renders it very dangerous at night.

Dangerous
shoal off Flour
Point.

The north-eastern point of Commissioner Island is a limestone ridge which shoals out for some distance and should be avoided, as well as the waters between the north end of this and the Twin Islands.

Channel north
of Commis-
sioner Island.

The course, followed by many pilots through the channel south of the lighthouse is to pass Commissioner Island northward until the Twin Islands open, then run to near the light, say half a mile at nearest, then steer to pass within half a mile of the north-west shore of Twin

Islands and continue on till the islands open again, then avoid the south shore of Berens Island.

Entrance to
Swampy
Harbour
Berens Island.

The entrance to the harbour on the west side of Berens Island is on a line at which the buildings at the dock close on the trees of the north-east side of the harbour. After approaching on this line till the first bushes on the bar close with Little Black Island, follow at the same distance along the bar to the dock. All the water of the east side of the harbour shoals from Berens Island and there are many reefs. As the bar is of gravel and sand built out from the island, deep water would naturally be expected along its face.

The old Swan River Harbour which was used by the inland boats of the Hudson's Bay Company is a small bay on the east side of Berens Island, a corner of which is sheltered by a gravel bar. This is useful only to small boats.

The channel to the east of Berens Island is occasionally used by passing near the north-east end of the island. Two reefs here have to be looked for—Cox's reef and one lying to the east of the present lighthouse.

Course to
Sturgeon Bay.

The course to Sturgeon Bay, where some time ago there was extensive fishing, passes between Outer Sturgeon and Bushkega islands midway, as long bars run from each island. As soon as the islands are passed the course turns sharply for the most easterly of the Sturgeon Islands till well past the reef marked to the west of Buskega Island. This island may be approached quite closely on the west, but there is only a very small opening to the east between the bars. The steamers generally pass to the east of Tree Island, and then south-west, passing well to the north-west of Round Island and thence steering for the mouth of the river. The low point north of the river is shallow, so that it is necessary to swing out a point to the south before making for the mouth.

PHYSICAL FEATURES.

THE WEST SHORE OF LAKE WINNIPEG.

West shore
of Lake
Winnipeg.

The plateau country through which the Great Saskatchewan River cuts its gorge at the Grand Rapids, as it falls to the level of Lake Winnipeg, is at a height of about one hundred and thirty feet above the level of the lake. Its eastern face forms a rather high escarpment extending from south of Long Point, northwards past the limits of the lake. The shore approaches the foot of this slope at the

mouth of the Saskatchewan, and follows it northwards at a gradually increasing distance. Near the Saskatchewan the shores are boulder-strewn, and no rock in place is noticed till north of Selkirk Island, where cliffs of limestone commence and are seen to the mouth of Limestone Bay. Southward from the river the general character of the country is more diversified. A spur of high land runs out to the east, forming the prominent Long Point of the map. The southern face of this is bold, but toward the north the slope is very gradual and on its surface many ridges of boulder-clay are found running northward. These seem to run in a direction parallel to the glacial striae and are of the nature of drumlins. The contour of the shore-line from the Saskatchewan River to the end of Long Point is evidently influenced very much by these ridges. Very good examples are seen near the Indian Reserve and also eastward. Long bays running to the south are found to have heavy boulder bars on each side at the mouth and ridges forming the sides.

Character of
shore north of
Long Point.



BOULDER-STREWN SHORE NEAR SASKATCHEWAN RIVER, FROM DENUDATION
OF BOULDER-CLAY RIDGE.

A section of one of these near the Saskatchewan shows boulders and pebbles in a light-coloured boulder-clay. Many of the pebbles are of limestone, and on the beach in front of this exposure, two miles east of the mouth of the river, are some large boulders of limestone rounded and polished by glacial action. The shore, to Long Point, is quite irregular, and apparently the water shoals away very gradually with many boulder-bars off the points. The south side of Long Point is more regular in outline, having higher country immediately behind the bouldery beach-ridge. On the north side are two large bays cutting in

Boulder-
strewn shore.

Shores of
Long Point.

toward the south, somewhat rounded by having sand-bars cutting off a portion of the southern part. The points between are principally low-lying, with boulder-bars off the central one. The remainder of the shore to the eastern end of Long Point is regular, with gravel and sand beaches. Evidence of the continuation of the Long Point ridge to the eastward is seen in the numerous boulders scattered far off the end of the point. Stratified deposits of sand are seen at the end of the point and extending along its south side for two miles, evidently overlying the till or clay composing the main part of the ridge forming the point. The angle or bay formed at the south-west side of the point is partly inclosed by gravel-ridges running from both sides forming a shallow harbour occasionally used by fishermen.

Wicked
Point.

Southward the shore is low, and at the first point is boulder-strewn, the boulders showing in shoals out in the lake. This is called Wicked Point, and possibly deserves its name. Near it is the first exposure of limestone south of the Saskatchewan River. The section is given here, as it seems to belong to a higher horizon than the other limestone exposures of the lake. The top of the rock is 14 ft. 5 in. above water, and the beds are in the following descending order :—

| | Feet. | Inches. |
|--|-------|---------|
| Hard dolomitic limestone with a few shells and corals, the whole more or less lumpy..... | 5 | 4 |
| Porous fucoidal dolomitic limestone..... | 2 | 3 |
| Thin white beds very much shattered and somewhat rotten, cavities filled with white clay-like material. | 3 | 4 |
| Yellow porous dolomitic limestone, fucoidal..... | 2 | 3 |
| Covered by shingle to water's edge..... | 1 | 3 |
| | 14 | 5 |

Exposure of
Silurian.

From one to two feet below the water are seen beds of a blue shaly limestone.

This exposure extends along the shore for about 300 yards, the apparently horizontal. Above is a thin deposit of two or three feet of boulder-clay, and at the southern end of the cliff there is a mass of this material piled up behind the rock. The clay contains a great number of limestone boulders, evidently from this ledge, with a few of granite or gneiss. The fossils obtained from this place, principally from the upper beds, seem to indicate Silurian age, of about the same horizon as the lowest rock at the Grand Rapids.

Low shores.

From this first exposure south to the next, there is very little variety in the shore-line. The country bordering the lake is low and flat, the rocks being covered by a thin coating of boulder-clay. Boulders are strewn on the points and gravel- and sand-bars extend between, forming the present shore-line. Behind this as a rule is a wet mossy muskeg reaching back to the higher, more thickly wooded

ground. About six and a half miles north of Dancing Point the shore is strewn with limestone fragments, and a mile south the underlying beds become exposed, showing eight feet of limestone in a series of receding steps. The beds, of a hard mottled dolomitic limestone, are thin or split into fragments. The exposed surfaces are rough and covered by fucoid-like markings. They resemble the Selkirk Island beds, and are apparently not far below those of the last exposure.

South from
Long Point.

These same beds are seen again about a mile farther south, and the shore is there generally covered more thickly with scattered limestone pebbles and gravel.

At Dancing Point, a low cliff shows 4 ft. 6 in. above the water, and extends 100 yards along the shore. The beds are nearly horizontal and the surface forms a flat table which has been somewhat smoothed by glacial action and shows a few striae. These are running nearly S 35° E., with some, seemingly older, running S. 63° E. This rock is a dark semi-crystalline dolomitic limestone, similar to that on Selkirk Island (north end), and contains a few badly preserved fossils of the same horizon as those found on the western shore opposite the north end of Selkirk Island.

Dancing
Point.

From Dancing Point southward, the shore for a short distance is very shoal and is strewn with boulders. The whole bay seems to be rather shallow. The first point south is boulder-strewn and but very little above the lake. Four miles from Dancing Point the beach gradually becomes freer from boulders, and is then almost entirely a sand-bar with low country behind. In the centre of this long bay a small stream, the War-path River, cuts through the sand-bar. In the spring no doubt the river is of some size, but at the time of our visit (August) the water flowing across the bar was only deep enough to float a canoe.

Near the War-
path River.

The next rock noted on the shore was a small exposure of yellow dolomitic limestone at Shiel Point. This is in a low cliff showing about 6 feet of apparently horizontal beds of fine-grained mottled dolomite. They are marked with fucoid-like markings, and vertical sections show numerous small cavities such as might be left from the dissolving away of salt crystals. The beds weather a dark yellow, almost an orange. In general appearance the specimens from this place have a resemblance to the rock at Stony Mountain. The top beds, three or four feet thick, are quite hard and fine-grained, while the lower ones are not quite so hard and seem to contain more earthy impurities. The beds exposed seem to be barren of fossil remains.

Shiel Point.

Rocks
resembling
Stony
Mountain
limestone.

Morass Point. The shore south around the rest of this bay has a fine high gravel- and sand-beach, but toward the southern point the country behind is low, in fact, a small lake lies back of the point and drains east to the lake farther to the south. The high bar ends at the above point, leaving the shore further south rough and shallow.

Carscallen Point. At Carscallen Point, several exposures of limestone are seen in horizontal beds rather dark in colour. Other exposures similar in nature occur along this shore as far as Clark Point, and details are to be found in the topographical descriptions of the Upper Mottled limestone.

Clark Point to Grand Island. South to Gravel Island, about four miles, the shores are high and well timbered, with a beach principally of limestone gravel. South of this island the shores are boulder-strewn.

Sturgeon Bay. Sturgeon Bay has a width of eleven miles, and from Tree Island to the mouth of the Mantagao River the distance is sixteen miles. In the mouth of the bay are seen the Sturgeon Islands, narrow boulder-strewn ridges, with groves of poplar and spruce. The remainder of the bay is open, but is generally not deep, the average being about three fathoms. The shores to the east are flat and low with boulder-bars in front, while to the south they are somewhat higher and steeper, having gravel beach-ridges. The bay at the mouth of the Mantagao River is nearly closed in by a gravel bar which is being built up from the west side, and the inclosed part is rapidly filling up, and is now mostly covered by rushes, making it a famous resort for ducks in the autumn. A low muskeg-flat extends from the east side of Sturgeon Bay to the bottom of Lynx Bay, so that from a distance the lake seems to extend through, thus apparently cutting off a portion of the land which terminates in Saskatchewan Point. On some of the older maps this part is called Lynx Island. In Lynx Bay it is found that this low strip is separated from the lake to the north by a high sand- and gravel-bar which now effectually seals the passage, otherwise in high water a canoe-route might easily be found through the marshy strip. Many examples of these high bars built entirely by wave action are found, and another may be here cited. The point known as McBeth Point, which is just to the east of Cat Head, is connected to the high land to the south-west entirely by a wave-built bar with perhaps larger proportions than any other on the lake, the material being ready to hand at the cliffs running from Lynx Bay to Cat Head. In Lynx Bay the limestone debris is found scattered all along the east side.

Lynx Bay.

High gravel-bar.

Kinwow Bay. Kinwow Bay is a long narrow inlet, with an average width of two miles opening out to the lake in greater width. The distance

across the mouth from McBeth Point to Willow Point on the east is over eight miles. At the upper end of the bay the country is fairly well wooded, and spruce of economic value as timber is reported on several small streams. Behind the beach on the eastern point of the bay is a series of sand-dunes, averaging from ten to fifteen feet in height. The timber seemed to be small. At Stony Point the sand and gravel is piled into a high heavy bar, projecting into the lake toward the east. The eastern end is protected by a small accumulation of boulders at the water-line. A line of boulder-bars runs from the extreme end of Stony Point to the shore, four miles to the south, probably the remains of a series of boulder-clay ridges similar to those forming islands to the north.

Stony Point.

Following the shore southward to the mouth of the Jackfish River, it is seen to be rather high and straight, with occasional small exposures of clay above the beach. These are found to be cuttings into the side of a ridge of boulder-clay, slightly modified, showing very faint traces of stratification. At the Indian Reserve at Jack Head, the timber has been cleared away and the ridge is clearly seen. It is about fifty paces wide on the crest, sloping to the swamp behind. The shore just here, by a series of curves to the south-east, leaves this ridge and gains two or three similar, though smaller ones, lying at short intervals to the south-east. The Jackfish River cuts through the first ridge, leaving its bed full of large boulders, flows through a low flat hay-meadow and issues to the lake through a gravel-bar over a boulder-strewn shore. Behind the gravel-bar the stream is deep to near the boulder-clay ridge, where the channel is filled by boulders. The shores southward are either low and muddy or boulder-strewn, according to the nature of the land behind. Where a boulder-clay ridge is reached, the points and shores are boulder-strewn, but otherwise the timber grows to near the water-line. The shores of Fisher Bay are all low, and the south corner is marshy.

Shore near Jack Fish Point.

Bouldery ridge cut by Jackfish River.

Fisher Bay.

The timber of the west shore has already been largely cut off, and two saw-mills, one on the west shore and one on the Fisher River, have ceased operations. On the east side, the shores are low and the country behind is also not elevated much above the lake. The points visited are merely reproductions of the same kind as that described on Moose Island, low boulder-ridges separated by swampy strips.

The shore to the south is fully described in dealing with the rocks exposed, but in brief, from Dog Head south to Little Grindstone Point, cliffs of limestone front on the lake. The south-western shores of Washow Bay are, however, low, and on the west shore of the southern

Character of shore to Big Island.

Big Island to
Red River.

part of the lake, from Big Island to the Red River, no prominent high points are found. The country, however, slopes up from the lake and many settlers' houses are seen in the cleared places. Steep shores are found near Gimli, but are seen to be cut-banks of stratified clay, a deposit formed when the lake was at a higher level.

RIVERS ENTERING THE LAKE FROM THE WEST.

The two large streams, the Saskatchewan and the Dauphin or Little Saskatchewan rivers have been previously described in various reports. The geology and general description of the Saskatchewan in the vicinity of Lake Winnipeg is given in J. B. Tyrrell's report on North Western Manitoba.*

A general description of the Dauphin River is also given by the same writer in the Summary Report for 1889.†

War-path
River.

A traverse was made down the southern branch of the War-path River, by crossing from the Little Saskatchewan River, at the bend, by a two-mile portage to the westward. The trail crosses a low country, imperfectly drained, half the distance being through wet mossy muskeg. Belts of timber of small growth, principally poplar and spruce, were passed through. The stream, at the point reached by the trail, is flowing in a small channel cut down only about five feet and fifteen feet wide. In the summer hardly enough water is running to float an empty canoe. Owing to the gradual descent, small accumulations of boulders serve to dam the water back in long quiet stretches. The general direction of this branch is north-northwest in a nearly direct line, almost a prolongation of the direction of the upper course of the Little Saskatchewan River. The country passed through is a gently sloping plane inclined to the north, wooded with poplar and a few fair sized spruce. No exposures of boulder-clay or any underlying rock were seen on this branch, and whether the till is modified or not is conjectural. The western branch joins that from the south nearly five miles west from the lake, and from there the course of the stream is changed to the east. The banks are only about eight feet in height in the lower part and continue to near the lake. The underlying rock is met with only near the lake, and consists of a hard, lumpy, yellow dolomite, succeeded by a close-grained, hard, yellow bed with numerous holes through it like worm-burrows. These resemble rocks belonging to the Stony Mountain section but the absence of fossils leaves the horizon very uncertain.

*Annual Report Geol. Surv. Can. vol. V (N.S.) 1890-91, p. 144 *et seq.*

†Annual Report Geol. Surv. Can. vol. IV (N.S.) 1888-89, p. 19 *et seq.*

Fisher River enters Fisher Bay from the west, at its extreme southern end. It rises to the south-west in several branches. The two principal ones meet at the Forks at a distance of about twenty miles from the mouth. The river is navigable for canoes to the Forks, and in that distance the fall is slight, being confined to three localities, a rapid at the Mission and two dams constructed by lumbermen farther up. The saw-mill near the mouth of the river was supplied by timber from some groves of spruce above the Forks, but these seem to have been exhausted. Of the country in the vicinity of the Forks the following notes were taken.—The banks are not very high, but the valley seems to be about 150 yards wide and fifteen feet deep. The surface of the country appears quite level with good soil. The timber, mostly poplar, has been burnt, and a large portion of this valley would in a few years become prairie. It was also learned that, to the west, the general character was that of a dry rolling country, covered by poplar with open meadows, but to the south-east much low swampy land occurs. From the stream very little spruce is seen. As to the nature of the underlying formations little could be learned. At the dam, four miles down from the Forks, a section of the bank showed one foot of black loam with stratified clay and a few pebbles. Boulders are found in the bed of the stream mainly at the rapids. Stratified sandy clay is also shown lower down, but this seems to be river deposit.

Fisher River.

The land bordering the stream at the lower part is reserved for the Indians. Their reserve is evidently a valuable one, having good facilities for agriculture and dairying. The Indians are living in well-built houses, with fine gardens, and many have good herds of cattle. On some of the farms were small fields of wheat, oats and barley, growing well. Fish, when not abundant in the river, are caught in the lake, but whitefish are seldom obtained nearer than Tamarack Island. The river is navigable for small boats of less than four feet draught up to the Mission and Hudson's Bay Company's establishment, while larger craft might, if the bar at the mouth of the river is cleared, reach the mill, about a mile up.

Indian Reserve at Fisher River

ISLANDS OF LAKE WINNIPEG.

Big Island is seventeen miles in length, and of an average width of three miles and a half. The western shore is low with hay-flats and marshes, but the eastern and southern portion is more elevated and better adapted to farming and stock raising. Nearly all the surveyed sections on this part are occupied by settlers of the Icelandic colony.

Big Island

Big Island. The higher parts are well wooded with poplar and some small spruce birch, &c., and the land has to be cleared for use. The northern part of the eastern shore is underlain by limestone, and often the soil is light and fit only for grazing purposes. The remainder is covered by a re-assorted glacial deposit, clay with some sand, and boulders are seen on the shores, especially to the south. Shoals occur south-west of the island extending out at least two miles from shore.

Black Island. Black Island, though not as large in area as Big Island, is much more prominent, as its surface inland rises much higher. Its length is twelve miles and a half, and breadth four and a half. It is well wooded, and a mill for some years was located at the south-west corner, engaged in sawing timber cut from various points near its shores. An iron-ore deposit on the south side has been known for many years, and on Jeffrey's map of 1762, showing Canada and northern part of Louisiana, Iron Island is shown a short distance south of the Narrows, evidently the same as the Black Island of to-day. A description of this deposit is given by Mr. Tyrrell, in the Summary Report for 1889, pp. 12-13.

Punk Island. Punk Island, to the north, is smaller, and is composed generally of the lower sandstone capped by thin beds of limestone. A small amount of timber, mostly black spruce, is found on the high parts, but birch and poplar are the prevailing trees.

Berry Island. Berry Island, in Washow Bay, lies well out to near the line between Grindstone Point and Bull Head, at a distance of six miles from the former. It consists of two masses of boulder-clay, the larger one to the south containing large angular blocks of limestone partly striated, and large boulders of Laurentian gneiss. The mass is in all probability lying on a part of the Winnipeg sandstones not eroded to the usual depth, having been protected previous to the passage of the glacier by a capping of limestone which if still exposed would be found above water-level, judging by the outcrops of the vicinity. There is evidence of a former point having connected this to the peninsula to the south-west, the remains being in the form of a line of shoal water and boulder-bars. The two masses forming this island are now connected by boulder- and gravel-bars forming a narrow neck in the centre.

Black Bear Island. Black Bear Island is a continuation of the limestone cliff of Dog Head. The island has been nearly cut in two by a deep bay running in from the south, which forms an excellent harbour for all classes of boats. On the outer side, the limestone exposed on the beach has been glaciated, and shows grooves running S. 48° W. Coming up from the

open part of the lake, and at right angles to the shore-line, are also seen several scratches resembling glacier markings, but irregular and sometimes slightly curved, and no doubt, due to the effect of the present lake ice shoving the boulders upward from the edge. Striae seen on the south-east side also run S. 48° W. There has not been much glacial debris left on the surface of the higher parts, and it is only seen in the boulders along the shores. Toward the western end the gneissic boulders increase in number, and for a considerable distance south-west form bars and small islands. Just west of this island, another smaller one seems to be made up entirely of boulder clay—the boulders from which form bars that run with few interruptions to near Narrow Island.

Snake Island is, like Black Bear Island, composed of limestone of the same character as Dog at Head. The eastern side is high, but it slopes down to a low shore on the west.

* Narrow Island shows only bouldery shores and is probably an oblong hill of boulder-clay resting on the limestone which is here not far below the surface.

The depth of the water surrounding these islands is not great, except to the east and south of Black Bear Island. In the pass south of Snake Island the depth at the narrowest part is fifteen feet, but shallows to the west, and in the bay into which Moose Creek empties, the channel up to the mouth of the creek is not more than five feet deep with a shoal in the centre of the bay.

Of the timber on these islands little need be said. A good deal has already been cut for use on the steamboats, and although comprising poplar, spruce and birch, it is all of medium size.

The Moose Islands, lying in the entrance to Fisher Bay, so nearly fill it that three comparatively narrow channels only are left. The larger one lies near the eastern shore, and is long and narrow, being thirteen miles long and averaging a mile and a half broad. Its shores are altogether of drift material and no evidence of older rock is seen. From the character of the bars at the extreme ends and of boulder-ridges along its eastern and western shores, the drift appears to be arranged in a series of interrupted parallel ridges of varying height, such as are called drumlins. The few islands in the channel to the east also show the same formation. Several of these are now connected by low land with the mainland to the east. The western side is straighter and with the exception of a few small bouldery points is much steeper.

Towards the north end a few ridges run northward, continued as bars out in the lake, and thus form narrow bays open to the north.

The northern point is very rough and large Laurentian boulders extend in a bar for at least half a mile beyond the point, toward the eastern bluff on Tamarack Island.

Little Moose
Island.

The western Moose Island is smaller and is generally called Little Moose Island. It is four miles and a half long and nearly two in width. At the north end, two ridges form the eastern and western points of a large open bay. The eastern ridge terminates in a long gravel- and boulder-bar, but farther south is scattered and several small ridges come out on the southern side of the island. The western ridge is continued across the island and forms shoals out in the lake to the south.

Scotch Islands
Group.

The Scotch Islands to the west of Rabbit Point is a group of islands which have been called the Scotch Islands. Locally, however, these are given individual names. The largest is Tamarack Island, a low wooded strip. Just to the north a small but higher one, well wooded, is called Little Tamarack, as it lies close to the end of the larger one. The others of the group are Egg Islands and Jack Head Island.

Tamarack
Island.

Tamarack Island is a long low strip of muskeg, seven miles and a half in extent and a mile wide, on which is a small growth of tamarack. This is relieved by three or four 'bluffs' of larger timber, occupying higher ridges or mounds toward the centre. The eastern part consists of a long low point stretching toward Little Tamarack Island. The eastern face of this has a high sandy beach-ridge behind which is a mossy muskeg bearing only stunted spruce and tamarack. The lake in front is shallow and full of bouldery shoals. The north shore is low, broken by a ridge of higher land running out to form a rough boulder-point. This ridge can be traced south-west across the island and forms a similar point to the south. Shoals running on this line extend northward to abreast of Little Tamarack Island, showing a nearly continuous ridge of bouldery material, probably of glacial origin running in the direction of the glacial movement. The waves of the lake are fast eroding the soft material of the western and northern shores where unprotected by the boulder-deposit, so that at several places stumps of trees are found standing out of the water, while the shore behind is apparently nothing but soft peaty matter. A few bars of gravel and boulders can be seen to the west and south, one opposite Little Jack Fish Point has a small grove of poplar on it and might therefore be called an island, possibly Louis Island of Hind's map.

Little Tamarack Island is a limestone ledge, low on the western side, but on the north rising ten or twelve feet above the water, showing

there ledges of thin-bedded limestone. The eastern face is built up principally from the broken material of the cliff, and has formed a high ridge behind which are several ponds and meadows. The northern half of the island is high and well wooded with spruce and poplar, but the southern part is mostly willow scrub with a few open meadows.

The Egg Islands are a connected chain of low bars which in high-water would be resolved into four. A few bushes on the smaller ones and one grove of larger trees, (the Bluff), on the largest, are all the foliage to be seen. These bars are evidently all of glacial origin, and seem to be a continuation of, or are similar to, the series to the south crossing Tamarack Island, and run generally in the direction of the glacial striae. The shores are generally very shallow, and the west side is much shallower than the east, many boulders being scattered some distance out,—about five miles. North of these islands is a high bar of limestone pebbles. This has no doubt been pushed up by ice from a submerged limestone ledge. As there are no bushes or other high objects on it, and from its position in the middle of the lake, it is dangerous to navigation and should be marked carefully.

The remaining island of this group is Jack Head Island, lying directly east of a point bearing this name. It is rather small, but quite prominent, being well timbered and high. In shape it is an oblong, a little longer than its breadth, which is half a mile. From its eastern point, which is piled high with limestone gravel, numerous small rock exposures are seen all along its northern and western shores, rising to about fifteen feet. The southern shores are generally low and boulder-strewn. The glacial striae were observed to run S. 25° W., or nearly parallel to the ridge composing the Egg Islands.

Commissioner Island Group.—A line drawn from Inmost Island to the eastern side of Berens Island, would run along a chain of islands that seem to be composed altogether of drift material, probably of the nature of drumlins, judging from the general direction of the chain and that of individual islands which is nearly parallel to the glacial movement. The southernmost one is a lenticular mass of boulder-clay covered with poplar and birch. From the south end runs a long gravel- and sand-bar nearly half a mile, then suddenly turning east it reaches nearly to Commissioner Island. The latter part is evidently recently built up by wave action with material derived from the larger bar. At the north end of the wooded portion, a small exposure above the beach, shows light-coloured boulder-clay. The second island in the group is larger or the wooded portion is of greater extent. Shoals seem to connect the two, and both occupy a position near the western

Twin Islands. edge of a shallow area reaching to Commissioner Island. The Twin Islands appear to be the visible parts of two ridges lying in deeper water. The shores are boulder-strewn and similar to Plunkett Island which lies half-way to Berens Island to the north. These, as noted before, have deeper water surrounding them, the steamboat channel passing to the south of Plunkett Island.

Sand Hill and Nut Islands. Another ridge or line of ridges crosses Commissioner Island from its north end to the southern point, following the west shore, and is continued south on Sand Hill Island and Nut Island. Sand Hill Island consists of two ridges, one slightly in advance of the other, while on Nut Island one ridge only is seen. The shores of both are strewn with boulders and bars extend toward the south end of Commissioner Island.

Commissioner Island. Commissioner Island is generally low, consisting of one series of ridges as mentioned above, to the east of which stretches a low tamarack swamp, somewhat like that of Tamarack Island, west of Dog Head. Cranberry Island is, however, the older term, and is descriptive of the general character of the island. At the north-east corner is found a large rectangular bay opening to the north. This was used as a harbour by the first steamer on the lake, the *Commissioner*. The shores are generally low and in sheltered parts the muskeg reaches to the beach. The point which forms the eastern side of the harbour is found to be a low shelving limestone ridge, covered mainly by boulders, and is continued far out under water, so that steamers from the south turn for the lighthouse channel only after opening the Twin Islands. Off the north shore, farther west, are extensive shoals with boulders showing occasionally, but they do not seem to extend as far north as the Twin Islands.

Berens Island. Berens Island is a long low wooded island lying to the west of Pigeon Point and the mouth of Berens River. Its longest diameter is a little over eight miles and lies in direction about north-east and south-west. The northern half averages about two miles wide, but south of this it is increased to nearly four miles by a projection on the east side. The east and west shores are not elevated much above the beach, but a ridge of higher land is said to run the length of the island from its extreme points. The shores are generally boulder-strewn and shoals run to the south-west and are also seen off the north point. Limestone ledges are found on the east side, generally low, shelving out under water with high ridges of shingle in their vicinity. Along the north side, smooth glaciated surfaces of limestones are found at the water's edge, and to the west, the beach,

after leaving the limestone exposures, becomes nearly pure sand, and is continued as a sand-bar nearly the whole distance to Little Black Island.

Little Black Island is formed from an exposure of horizontal beds of limestone, the debris from which has produced a beach and two bars, running to the east and nearly connected with the sand-bar from Berens Island. On the outer shore is a cliff of over twelve feet of fractured limestone beds, the shingle from the denudation of which spreads nearly around the island. On the higher land of the central part is a thick grove of black spruce, and though the island is of small extent—half a mile in diameter,—it is conspicuous. In the bay between this and Berens Island, formed by the projecting bars, a small harbour has been used for some years by the fishing companies.

Little Black Island.

To the south-east of the entrance to Kinnow Bay a small island lies within one mile of shore. It is oval in shape, pointing to the north, and is about half a mile in length and twenty chains in width. It is well wooded with poplar, birch and spruce, and seems to be high in the centre. This is probably a mass of boulder-clay lying on the surface of the flat-lying limestone which is exposed on the northern beach. This island is marked on Hind's map, (1858) as Birch Island, but since then, various collections of fossils brought from there have been labelled 'Inmost Island.'

Inmost Island

On the northern end the beach is strewn with flat slabs of a fine grained dolomitic limestone, containing many rounded concretions of dark cherty matter, averaging about four inches in diameter. The eastern and northern shores are piled high with pebbles of this rock, but the western side is mostly covered with gneissic boulders on the shore and scattered on its slope out into the lake. From the southern point a bar of limestone gravel extends southward to very near the mainland. Near the island this bar is high, but it gradually lowers, the greater part of its length being just below the water-level. Northward from the island a few bars are visible, being probably ledges of the underlying rock scattered over with boulders. Half way to McBeth Point another shoal shows a line of boulders just above the water. In the bay east of the island there is a depth of twenty-four feet with rock bottom and also about the same immediately to the west.

Lying off the eastern entrance to Sturgeon Bay, and northward from Saskatchewan Point, are three quite prominent islands. The most northerly one of the group is known as Outer Sturgeon Island

Outer
Sturgeon
Island.

and is the only one on which the underlying rock is exposed--although the presence of gravel-bars on some of the others would suggest the probability of the limestone being not far below water-level. The Outer Sturgeon Island has a diameter of about one mile and in shape is nearly square with the diagonals pointing to the cardinal points. The broken material from the cliff at the north point has been carried for some distance around the island, seemingly in both directions, toward the south end where there is a mass of this gravel forming a bar. The south-western end is all low, but along the shore is a gravel-ridge behind which are several marshy ponds. This beach-ridge is high, averaging eight and ten feet above lake-level. Part of the material has been pushed up from the lake, as the bar is no doubt built on the shelving limestone, but a large percentage has been transferred from the northern end. At the extreme south point, the gravel is being carried from both sides out into the lake forming a bar which at present extends half a mile from the island.

Inner
Sturgeon
Island.

Nearer Saskatchewan Point are two islands. These are probably the Bushkega Islands, of Hind's map. The western one is commonly called Inner Sturgeon Island, and is the largest of the group, being over two miles in length but not very wide. It is formed by the junction of two long narrow islands, the one lying in advance of the other, the northern one slightly to the east. Between these a high gravel- and sand-bar has been built, forming a bay open to the north-west, but affording good shelter from the east and south. The water in this bay is deep, soundings in the centre giving eighteen feet outside, thirteen just inside the points, and eight feet close to the bar. The shore of the east side of the bay, as well as the point at the west, is rough with large boulders. These two masses which form the island are both strewn with boulders. The shores are rough, and to the north and south extend long shallow bars on which at intervals are seen large boulders showing above the water. The shoal running northward commences at the extreme north-eastern point, and runs north, and for about a mile boulders can be seen. The steamboat channel is a little north of the middle of the opening between this and outer Sturgeon Island. To the south, the lake is quite shallow with numerous bars running off from this island.

Bushkega
Island.

From off the eastern part of the island a long bar extends south to near the other Bushkega Island, which is smaller than the first and is formed in a similar manner, a couple of masses of till forming two islands have become joined by a wave built bar. The eastern half is

well wooded, and besides a lot of Laurentian boulders on its shores it has a considerable extent of gravel and sand-beach, especially at the southern end where the gravel is piled into a high bar. The channel south, between this and the mainland, is at present very shallow, although in early times this is said to have been the usual boat-route and formerly used by some of the steamers. The bar from the island is now built nearly across the bay but shows only at intervals above the water.

In the middle of the mouth of Sturgeon Bay there is a group of small islands eleven in number, called Sturgeon Islands. They are all either long ridges or lenticular masses forming narrow islands, and are all lying in a general north-and-south direction. As to structure, some of them are quite low with a heavy beach-ridge generally of boulders on the more exposed side; others, such as Tree Island have a higher ridge probably of boulder-clay running down their length, flanked by beach-ridges. These boulder-clay ridges are sometimes interrupted and some of the islands at the eastern side of the group are evidently formed of several pieces of a ridge joined by the beach-ridge. Their shore-lines show nothing but transported material,—boulders of gneiss and a fine-grained limestone like that at Cat Head,—but of solid rock nothing is seen. As all these ridges lie approximately in the direction of the glaciation, they may be described as drumlins.

The large island lying north of the St. Martin Islands is locally known as Reindeer Island. It is nineteen miles in length, with a greatest breadth of six and a half, but an average of four miles. The surface is all low, consisting of patches of timbered land surrounded by hay-flats or marsh, so that it has, from a distance, the appearance of a cluster of islands similar to those farther south. Its shores are not bold and along the south-east side are protected by shoals. From the south point along the eastern side there is a short distance in which the shore seems slightly higher, and in one place rises to seven feet, showing light-gray boulder-clay with limestone fragments and pebbles of Archaean gneiss. A little south of the middle of the eastern side an island lying just off the shore has been connected with the main shore by a sand- and gravel-bar running from the north. Behind this the bay forms a land-locked harbour which, in low water, can hardly be used as such, since the entrance is too shallow. In the summer of 1890, the depth of water in the bay was about four feet and in the channel leading to it about two feet, with a rough bouldery bottom. A few years previously this was used as a harbour by the fishing craft, an entrance being then found through the sand-bar, but this has since closed up.

Near the north point, boulder-clay was again seen, containing small pebbles, but the shore was strewn with slabs and boulders of a mottled limestone containing *Maclurea Manitobensis*. This seems to be the same rock as that at Little Black Island, but it is not seen here in place. The larger boulders are glaciated, and as many of them are broken, the striae appear on one side only.

Western
shores of
Reindeer
Island.

The north-western shore has one large indentation running to the south-east and on the west side of this a small harbour has been used by the fishing companies. In front of this bay are several islands—four of them timbered, the rest merely shoals. They all seem to be formed of drift material, but some derive their shingle probably from shelving limestone beds beneath the water, as several have strong beach-ridges of limestone pebbles. The possibility of there being limestone beds here, but slightly submerged, is confirmed by the fishermen, who report at the western point near the harbour, a flat table of rock which appears at very low water. The south-western side is low and the shores near the south end are without beaches, being protected by many islands and shoals. The timbered bluffs come out to the shore and form points with low land lying between, often in the form of hay-flats that seem to run nearly across the island. An elevation of ten feet in the level of the lake would resolve the southern end into a cluster of islands corresponding to that lying just to the south—the St. Martin Islands.

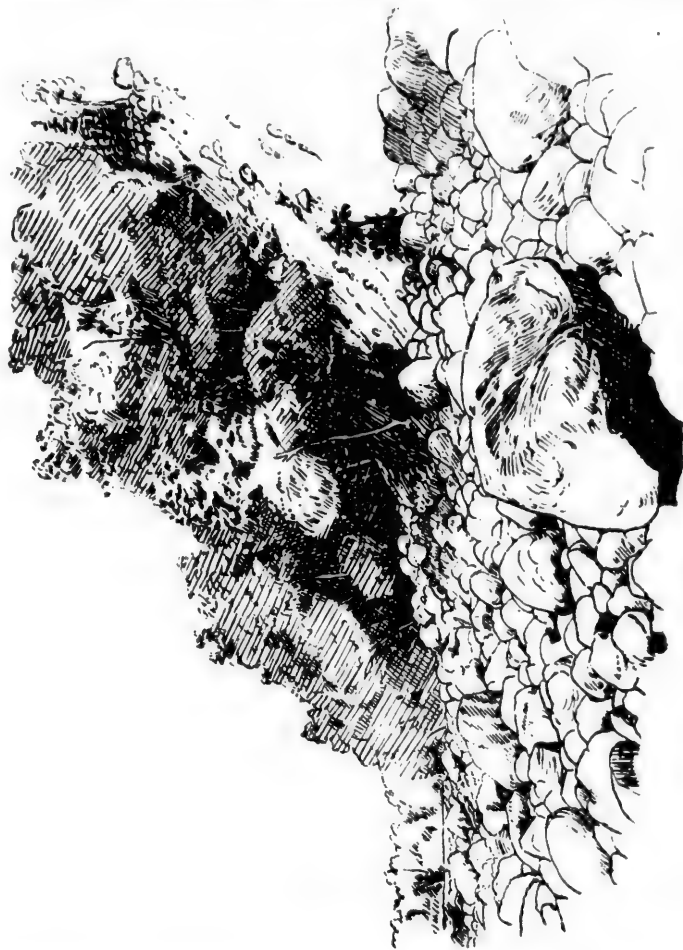
St. Martin
Islands.

These seem to be a series of small narrow islands, many of them in line connected by shoals, showing them to be merely higher points of an interrupted ridge. Others are oblong masses of till, and where exposed show an unstratified mixture of light-coloured clay containing large Archaean boulders. The islands generally have their longer diameters running north-and-south, and are flanked on both sides by bouldery beach-ridges. Exposures of limestone may be found on some during very low water, as several of the larger ones just to the south of Reindeer Island have, added to them, large bars of limestone pebbles which are probably derived from below the water-line.

George Island.

George Island, being formed by a high plateau connected to a strip of lower land, first appears as a high island only two miles long, but from a nearer view two isolated bluffs to the south-east appear as separate islands. These are, however, included in a high sand-bar stretching from the larger part to the eastward, the outer bluff being at the extremity of the bar. The main body of the island is about two miles long, in a north-west and south-east direction, and a mile wide. On the southern shore the highest point is estimated at seventy

feet. As far as could be seen the hill or plateau forming the island is composed principally of sand and clay, with the upper part only exposed. Where a small exposure was seen it consisted of a liberal



BOULDER BEACH, GEORGE ISLAND.

assortment of boulders at or on the surface of a bed of water-worn gravel and pebbles rudely stratified, with sandy beds below. The face of the bank was everywhere hidden and covered with vegetation, so that a complete section could not be made. The beach in front of

Bouldery
shores

this escarpment is a heavy boulder-ridge, the boulders seeming to run out into deep water. Towards the west the top of this escarpment is not as high, averaging about forty feet, with the same character. In a bay on the western side, the boulder-beach is replaced by sand, and the banks behind are also of sand piled in high dunes, one or two reaching fifty feet. The northern end of the island is of gravel and boulders, though the banks are not very high. On a point on the eastern side, cleared of timber by fire, the edge of the terrace can be seen from the shore, at an elevation of about twenty feet above the water. It is entirely grass-grown and boulders are liberally scattered on its surface and on the slope.

Formation of
eastern part.

The two outlying wooded patches seem to have been separate masses of boulder-clay, as their north and south ends terminate in bouldery points. The higher part of the island is evidently a terrace sloping to the north, and where worn into by the lake, as it is on nearly all sides, it leaves piled up in front of it a high ridge of boulders.

Little George
Island.

Little George Island, west of George Island, is small and triangular in shape, with the apex pointing south. On the south-west side, the lake is cutting into the western side of a ridge which runs from the south end of the island towards the north. The eastern shore is low, but has a strong shore-ridge of boulders. The northern side or base of the triangle is a sandy bay with sand and gravel-beaches. From the two points shoals run north and north-easterly, which protect the bay from all but northerly winds. The northern point and all the west side is thickly strewn with boulders and there appears to be a line of shoaler water farther north, as there are several boulder-bars lying a couple of miles from the island. Evidently the ridge, which is highest at the south end of the island, has been greatly denuded. South of the point of the island the water is deep, and the shores to the south and west are steep.

Ridge of
gravel and
sand.

The ridge is about 300 yards long and rises some thirteen to fifteen feet above the bouldery shore, or twenty-one feet above present water-level. The surface is strewn with water-worn or glaciated boulders, partly embedded in the soil; beneath this, as far as could be learned, the whole mass of the ridge is of gravel with a little sand. The pebbles are all of Laurentian material and well rounded.

Sandy Islands.

The group of islands farther out in the lake and north of Little George Island are known locally as Sandy Islands. These are three in number, lying approximately on a line pointing towards Long

Point and the George Islands. The middle one is the largest and highest of the group and is somewhat irregular in shape. The southern part is high and at the south point there is a hill about fifty feet high. Boulders are strewn on the surface and falling down the slope of gravel, sand and clay which forms the hill, help to swell the pile of boulders which here form the beach. Running east from this boulder point is a long gravel shore, behind which is seen a terrace of stratified sand and gravel. The surface of this slopes regularly from the high hill seen at the west, towards the eastern point of the island. At the middle of the bay, the escarpment is a short distance back from the shore and the top of the bank is about fifteen feet above water, but rises rapidly toward the west. This bay and a small one on the west side are free from boulders on the shore, but all the rest of the shore is thickly covered, more especially the south-western part. The northern and eastern points are low with bouldery shore-ridges. The other two islands of this group are both long narrow ridges of gravel and sand covered by a lot of boulders, making rough shores. Between the western island and the middle one are several shoals. South of the eastern island, and out to a distance of a mile and a half, are several shoals lying in the direction of Little George Island. These seem all to be of gravel and boulders and are lying in a general north-west and south-east direction. To the west of the group the water appears to be deep, that is, the average depth is about ten fathoms, which is also found between the islands and Long Point. Of the trees on these islands it may be said that besides a scattering of spruce and birch the main timber is poplar. On the higher part of George Island and the middle of Sandy Island there is some spruce of a medium size.

Selkirk Island lies ten miles north from the mouth of the Saskatchewan River. Its length is five miles, with an average breadth of a mile. The shores are generally boulder-strewn, but intervals are seen occupied by limestone beds in place. These exposures are noted under the general descriptions of the Upper Mottled limestones, and occur at the north end, on the west side and near the south-east corner. Gravel-beaches are always found associated with the rock exposures. Those at the north end, furnish a large mass of material which on the west side of the island is formed into a long hook, behind which is an excellent harbour. The whole island is wooded generally with spruce and poplar. Near the harbour at the north-west point, a clearing has been made for a fishing station and the timber cut appears to be small, consisting of spruce and tamarack.

Horse-shoe
Island.

Horse-shoe Island, called, locally, Pony Island, is a small wooded limestone knob just off the south-east corner of Selkirk Island. The limestone debris from the eastern face of the low cliffs has been carried westward by wave-action around both north and south points, and this is continued towards the large island in the form of two long bars, thus inclosing a small bay which is extensively used as a shelter for fishing boats, and may probably be found large enough for a fishing station. The shape of the island is thus, roughly, a horse-shoe with the opening toward Selkirk Island and the wooded part occupying the toe portion of the shoe.

SYSTEMATIC GEOLOGY.

CAMBRO-SILURIAN.

Correlation of formations.

Cambro-
Silurian in
Winnipeg
basin.

The Cambro-Silurian is found resting on the uneven surface of the Archæan and conformably below the Silurian which outcrops at the Saskatchewan River, Lake St. Martin and in several other places south to Stonewall—while the Archæan forms the eastern shore of Lake Winnipeg, leaving thus a long strip in which the Cambro-Silurian is seen. The lower member is a sandstone followed by shales and limestones bearing fossils of Trenton age. Above this, red shales and reddish and white limestones form the beds referred to the Hudson River or Cincinnati formation.

Formations in
Minnesota.

In Minnesota, the sections carefully worked out show that below the Hudson River formation—divided there into two divisions—are found beds of the Trenton, Black River and Chazy formations, while in Manitoba no rocks are found below the Black River and of that the upper part only.

The following table of formations for Minnesota and Manitoba shows the positions relatively assigned to the Manitoba formations :—*

*The subdivisions in Minnesota are those adopted in the introduction to part II of vol. III Geology of Minnesota.

Table correlating formation of Manitoba and Minnesota.

FORMATIONS IN MINNESOTA

FORMATIONS IN MANITOBA.

| Hudson River or Cincinnati Period. | | Trenton Period. | |
|------------------------------------|------------------------|-------------------------------------|--------------------------------|
| Richmond group. Utica group. | Trenton group. | Maclurea beds. | Stony Mountain Utica ? |
| | | Fusipira and Nematopora beds. | Limestones and shales. |
| | | Clithambonites beds. | Upper Mottled limestone. |
| | | Fucoid and Phylloporina beds. | Cat Head limestone. |
| | | Ctenodonta beds. | Lower Mottled limestone. |
| Black River group. | Black River group. | Rhinidictya bed. | Winnipeg sandstone and shales. |
| | | Stictoporella bed | |
| | | Vanuxemia bed. | |
| Stones River group. | Stones River group. | * Lower Buff. | |
| | | St. Peter Sandstone. | |
| Chazy formation | | | |

Stony
Mountain
formation and
Richmond
group.

The limestones and shales at Stony Mountain contain a great number of fossil forms, many of them also found in both the Richmond group and the Utica group of Minnesota, and it is quite possible that if the section were complete at Stony Mountain, the upper beds with part of the shales beneath could be correlated with the Richmond group and the lower shales with the Utica.

Trenton of
Manitoba and
of Minnesota.

Of the Trenton group in Manitoba, the most striking dissimilarity to that to the south is the great increase in thickness. It comprises about three hundred feet of beds of limestones with very little shale, while in Minnesota, though the thickness varies considerably, the extreme thickness, or that given for Fillmore county is one hundred and fifty nine feet. The divisions adopted in Minnesota are based on the prevalence of certain typical forms of fossil remains found in each, and the beds so distinguished require careful examination to recognize. This method of subdivision seems necessary from the recurrence of beds of similar character throughout the section, but in Manitoba the divisions are made on broad distinctions in the general appearance of the beds, and are easily recognized in the Lake Winnipeg basin. The presence of nodules of chert in the Cat Head limestone is one but not the only distinguishing feature, and in comparing it with the section of the *Fusispira* bed of Prosser's ravine, near Wykoff, Minnesota, it is noticed that a thickness of nine feet is found having the same character. The fossils that distinguish the upper division of the Trenton in Minnesota are found distributed throughout the whole of the Trenton of Manitoba, and many of those of the lower divisions in Minnesota do not seem to be so characteristic of the same beds in the northern basin.

Winnipeg
sandstone a
basal
formation.

The basal member, the Winnipeg sandstone, contains in its upper part shaly beds which in drill-holes elsewhere to the south-west in Manitoba are shown to become shale. The few fossils found are either representatives of forms in the Trenton above or occur, in Minnesota, in the Black River shales and occasionally in the *Clitambonites* beds, the lower division of the Trenton. The character of the deposit and that of the few fossil forms found, induces the belief that it represents the upper part of the Black River formation.

TRENTON PERIOD.

Various
names given
formations of
of Trenton
Period.

The limestones, which in Wisconsin are readily separated into two divisions, Galena and Trenton, become less distinct in Minnesota, and have caused considerable trouble in their correlation there. In many

papers and reports published by both the Minnesota and Canadian surveys, the Trenton has been referred to variously as the Galena, Galena-Trenton and Trenton. Beds now referred to the Black River group were assigned variously to the Upper Trenton and Upper Blue limestone and the Blue Carbon.

The limestones of Lake Winnipeg basin are referable to those previously called the Galena limestones. The latest designations for the Minnesota divisions are given in the Final Report of the Geological and Natural History Survey of Minnesota.*

In discussing the age of the Galena limestone, Prof. N. H. Winchell sums up by saying :—

Age of Galena limestone.

‘It may therefore be concluded that the Galena limestone is only a phase of the Trenton intensified in the typical region and fading out in all directions.

‘It is a convenient designation in Iowa and some parts of Wisconsin and Illinois, but in Minnesota its convenience hardly warrants its continued use. The physical break and the faunal change which follows it in the North-west are probably parallels of those which mark the transition from the Trenton to the Hudson River (Utica slate) horizon, to which Mr. Walcott has called attention.†

Similarly, in Manitoba, lithological distinction between the various beds can be traced as local variations, but they are not like those farther south. The whole series contains fossils common to all the beds, while lesser divisions seem to have, in addition, forms which characterize each horizon. Further research may help to widen the range of these latter species.

The three subdivisions proposed for the Trenton formation of Manitoba are made mainly on lithological distinctions, together with a prevalence of the typical forms of animal remains characteristic of each.

Subdivisions of Trenton formation in Manitoba.

The upper part, consisting of 130 feet of light-yellowish mottled limestone, is found exposed at East Selkirk, Lower Fort Garry, and Selkirk Island at the north-western part of the lake, and will be discussed under the name of *Upper Mottled limestone*.

The central portion, consisting of homogeneous, generally fine-grained, yellow limestone, more or less magnesian, and containing cherty nodules scattered throughout its seventy feet of thickness, is discussed as the *Cat Head limestone*, from the locality at which they are best developed.

* Vol. III, part 2.

† American Geologist vol. XV, No. 1, p. 33.

The lowest division is a dark-yellowish to grayish-white mottled limestone, found exposed along the more eastern points of the west side of the lake, and termed the *Lower Mottled limestone*. The thickness of this division amounts to about seventy feet.

List of fossils
found in all
divisions of
Trenton
formation.

As noted before, larger collections of fossils will doubtless greatly add to the lists here presented, and mainly to that given first for those forms which have a vertical range through all these divisions. The following lists have all been compiled from *Palæozoic Fossils*, Vol. III, Part III.

List of species known to range through the limestone beds of the Trenton formation of Manitoba :—

- Receptaculites Oweni*, Hall.
Pasceolus gregarius, Billings.
Halysites catenularia, L., var., *gracilis*, Hall.
Columnaria alveolata, Goldfuss.
Streptelasma robustum, Whiteaves.
Calapœcia Canadensis, Billings.
Strophomena trilobata, Owen.
Rafinesquina lata, Whiteaves.
Plectambonites sericea, Sowerby.
Orthis (Dinorthis) subquadrata, Hall.
 " *testudinaria*, Dalman.
Platystrophia biforata, Schlotheim.
Rhynchotrema capax, Conrad.
 " *inequivalvis*, Castelnau.
Salpingostoma Buellii, Whitfield.
Pleurotomaria muralis, D. D. Owen.
Hormotoma gracilis, Hall.
Maclurea Manitobensis, Whiteaves.
Trochonema umbilicatum, Hall.
Fusispira inflata, M. and W.
Endoceras subannulatum, Whitfield.
Actinoceras Bigsbyi, Bronn.
Actinoceras Allumettense, Billings.
Poterioceras nobile, Whiteaves.
Oncoceras Whiteavesii, Miller.
Trochoceras McCharlesii, Whiteaves.
Asaphus (Isotelus) Susse, Whitfield.
 " " *maximus*, Locke.
Ilænus Americannus, Billings.
Bumastus Trentonensis, Clarke.

The Winnipeg sandstone.

The basal beds of the Cambro-Silurian of Manitoba consist of a series of soft friable sandstones, shaly in the upper part, but generally similar to those found in Minnesota beneath the Trenton limestone. Very few fossils have been obtained, and those from the upper part only, denoting merely lower beds of the Trenton. The following are the species found:—*Licrophycus Ottawaensis* (Trenton); *Serpulites dissolutus* (found also in the limestone above, at Punk Island); *Rhynchidictya mutabilis* (Black River, at Minneapolis and St. Paul); *Escharopora ramosa* (Black River, at Minneapolis); *Strophomena trilobata* (also found in limestone above on Lake Winnipeg running to Upper Mottled limestone, and from middle beds of the Galena of Minnesota); *Orthis testudinaria* (runs through Trenton to Stony Mountain, in Manitoba); *Cyrtodonta Canadensis* (Trenton and Black River at Ottawa); *Aparchites Tyrrellii* (found only on Black Island), and also, an undetermined species of *Conularia*. The fossils give no definite information as to the age of the beds, but suggest a passage from Black River to Trenton.

In eastern Canada and New York state, the Black River is usually a thick-bedded limestone, but in Minnesota it is composed mainly of greenish shales; so that the shales below the limestone in the borings at Rosenfeld and Selkirk may be taken as the passage beds from the Black River. These are represented on Lake Winnipeg by shaly bands in the upper part of the section. The sandstone below, being in the nature of a shore-deposit, though occupying a position nearly similar to the St. Peter sandstone of Minnesota, can not be regarded as definitely of the same age, since no evidence of Chazy fossils has been found in it.

The thickness of pure sandstone in the Lake Winnipeg basin is apparently much less than to the south. The several sections give varying thicknesses owing to the uneven nature of the floor on which it was deposited. Those at Grindstone Point show forty feet of beds, while the channel of the lake just in front of the exposure has been eroded by glacial action and kept clear by currents to a depth of fifty feet. This is probably not carried down to the lowest point in the Archean floor, but, with the exposed section, probably represents ninety feet or more of easily eroded beds. At Dog Head, the base of the limestone is probably only a few feet below the lake-level, and the channel in the immediate vicinity has been eroded to a depth of ninety-six feet. On Black Island, exposures of similar beds form a nearly continuous section of about one hundred feet.

Thickness of formation.

If the plane formed by the base of the limestone beds capping the cliffs of Grindstone Point, Little Grindstone Point, Punk Island and Black Island were projected eastward, it would be found that a varying thickness of sandstones might exist beneath it, amounting in some cases to more than one hundred feet, but in others, along the east shore, to much less. It is also apparent that east and north of Dog Head the limestones must have been deposited immediately on the Archæan.

Lower beds.

The lower beds are exposed on the east end of Punk Island, and are there found to be soft, clean sandstone, stained in places by iron-oxide from underlying Huronian rocks. The upper beds are exposed in fine sections on Deer Island and along the north side of Grindstone Point, and show shale partings between the upper layers which are false-bedded. The shale predominates in the thin beds, which are from

Upper beds.

twenty-five to fifty feet below the top and correspond in general aspect at both the exposures. Westward and southward this upper part seems to be made up mainly of shales, and may be a continuation of those that in Minnesota hold Black River fossils.

Lower Mottled limestone.

Lower Mottled limestone.

This division is the lowest member of the limestone series and rests directly on the basal sandstones and shales. These limestones form the principal part of the sections at Grindstone Point, Bull Head and Dog Head and on the islands north to Berens Island. The combined section given by these several exposures, amounts to a thickness of about seventy feet. The lowest beds are those seen at Deer Island and Grindstone Point capping the sandstone. Immediately above are the beds occurring at Dog Head, followed by the upper part of the Black Bear Island exposure. Those on Tamarack and Jack Head islands are evidently higher, but belong to the same series and form, together with those mentioned above, the following descending section:—

General section.

- | | Feet. |
|--|-------|
| (1) Hard mottled limestone, dark-yellow, with brownish-yellow spots, breaking up into lumpy fragments not wearing discoidal on the beach but irregular. A few pieces from top beds are not so mottled and break smoothly (probably base of Cat Head limestone)..... | 15 |
| Exposure on west side of Jack Head Island. | |
| (2) Thin-bedded, mottled buff and grayish-white limestone, weathering ashy-white, in which are many large cephalopods: <i>Orthoceras</i> , <i>Sactoceras</i> , <i>Potrioceras</i> , <i>Oncoceras</i> and <i>Cyrtoceras</i> , while specimens of <i>Maclurea Manitobensis</i> and <i>Receptaculites Oweni</i> are abundant..... | 15 |
| Eleven feet of these beds are exposed on Little Tamarack Island and similar beds are exposed on Little Black Island near Berens Island. | |

| | | |
|---|----|------------------|
| (3) Mottled limestone, buff-coloured but weathering lighter, in rather thicker beds than above and not so rich in fossils. | 10 | General section. |
| These form the upper part of cliff on Black Bear Island. | | |
| (4) Thin beds of similar rock, rich in fossil remains. | 20 | |
| This band occupies the lower portion of the exposures on Black Bear Island, on Snake Island and Dog Head or Whiteway Point and the upper part of the cliffs of Bull Head and intervening exposures. | | |
| (5) Darker, mottled, impure limestone, where not weathered, almost blue on fracture, fractures into thin flags with surfaces covered with fucoidal markings. The lower beds are of very earthy limestone resting on the sandstone of the basal series | 10 | |
| | 70 | |

No. 5 is seen at the top of the exposures of sandstone on Deer Island, Punk Island, Grindstone Point and in the lower part of cliffs at Bull Head. The beds on the east end of Commissioner Island resemble this latter member and are probably an upward continuation of it.

The different beds enumerated in the above table are all very similar but can be recognized in the field. The line of division for the top is arbitrary and for convenience only. Between the three upper members there may be slight gaps, but they are thought to be of a few feet only, if any.

The fossils found, generally range through either the two lower divisions or through the whole series, but a few seem to characterize this division only, and from the table submitted it will be seen that the following as yet belong exclusively to the lower beds:—*Climacograptus bicornis*, *Solenopora compacta*, *Chertetes perantiqua*, *Serpulites dissolutus* (also found in sandstones immediately below), *Stomatopora Canadensis*, *Diplotrypa Westoni*, *Lingula Iowensis*, *Clitambonites diversa*, *Anastrophia hemiplicata*, *Rafinesquina Leda*, *Orthis pectinella*, *Platystrophia biforata* var., *crassa*, *Cyclospira bisulcata*, *Modiolopsis parviuscula*, *Vanuxemia Hayniana*, *Hormotoma Winnipegensis*, *Solenospira pagoda* var., *occidentalis*, *Trochonema niota*, *Loxonema Winnipegense*, *Actinoceras Canadense*, *Orthoceras Winnipegense*, *Ascoceras costulatum*, *Potrioceras gracile*, *Oncoceras magnum* var., *intermedium*, *Cyrtoceras Manitobense*, *C. laticurvatum*, *Eurystomites plicatus*, *Discoceras Canadense* and *Aparchites parvulus*. Of these the following are found in the Black River group of Minnesota:—*Solenopora compacta*, *Orthis pectinella*, *Solenospira pagoda* and *Trochonema niota*, while the following are found in the Trenton Group (formerly the Galena):—*Lingula Iowensis*, *Clitambonites diversa*, *Anastrophia hemiplicata*, *Platystrophia biforata* var., *crassa*, *Cyclospira bisulcata*, and *Vanuxemia Hayniana*.

Fossils found in this division only.

*Cat Head Limestone.*Cat Head
limestone.General
character.

The central portion of the limestone series, is best developed at the prominent point on the west side of Kinnow Bay, called Cat Head. The beds are of a fine-grained, evenly coloured, yellow dolomitic limestone, with numerous concretions of dark-coloured chert, filling cavities apparently left by the decay of corals. These beds are seen in the high cliff at Cat Head, and along the shore to Lynx Bay. At the western end of the section, three miles west of Cat Head, the cherty concretions attain large dimensions. Several are over a foot in length, and one measured two feet by ten inches. The lower beds are fine-grained, resembling lithographic stone and are very rich in fossil remains. The total thickness as observed on the lake is sixty-eight feet. This includes the top beds of Cat Head and Outer Sturgeon Island, which are similar in colour but coarser in texture, becoming finally crystalline. The section is made up as follows:—

| General section. | | Feet. |
|---------------------|--|----------|
| | | |
| | (1) Hard, flinty, coarse-grained limestone (Sturgeon Island)..... | 10 |
| | (2) Yellow, granular limestone, weathering roughly and slightly honey-combed (Cat Head)..... | 8 |
| | (3) Similar coarse-grained, weathering dark-yellow, with fucoid-like markings, and very much honeycombed (Cat Head)..... | 3 |
| | (4) Yellow limestone with fucoidal markings similar to No. (2) (Cat Head)..... | 10 |
| | (5) Fine-grained yellow rock with numerous ashy coloured spots scattered over the whole face of the exposure, from the weathering of small impure flinty concretions (Cat Head)..... | 27 |
| | (6) Fine-grained yellow limestone, rich in fossil remains, with numerous large concretions of dark cherty material (Cat Head, McBeth Point and Inmost Island)..... | 10 |
| | | <hr/> 68 |

Distribution.

The area over which these beds might be exposed is in the form of a belt running parallel to the eastern outcrop of the Lower Mottled limestone. This would be in a NNW. and SSE. direction, but owing to the mantle of drift, these beds are exposed only in the typical localities and at the base of the cliffs north of the Saskatchewan River. They are recognized in the drillings from the Selkirk well where fine grained yellow limestone fragments, with about ten per cent of quartz, are supposed to represent the lower beds of this series, in which are found the flinty nodules noted above. Loose fragments of these rocks are found on the shore west of Big Island, on the islands in Fisher Bay, and on Reindeer Island, west of Cat Head.

Fossils found
in this
division only.

The fossil species found only in these beds, and probably characteristic, are:— *Chondrites* (*Bythotrephix*) *patulus*, *C. cuneatus*, *C. cupressinus*, *C. gracillimus*, *Aulacopella Winnipegensis*, *Trichospongia*

hystrix, *Thamnograptus affinis*, *Lingula elongata*, *L. obtusa*, *Rafinesquina deltoidea*, *Zygospira recurvirostra*, *Palaeopteria parvula*, *Ctenodonta astarteformis*, *C. subnasuta*, *Clinopistha antiqua*, *Rhytimya recta*, *Edmondia vetusta*, *Pleurotomaria margaritoides*, *Liospira persimilis*, *L. angustata*, *Trochonema eccentricum*, *Conularia asperata*, *Asaphus gigas*, and *Bronteus lunatus*.

The two lower series—the Cat Head and the Lower Mottled—are not of any great thickness, but are in the district readily distinguished from each other. The dividing line is placed at a bed, at which the mottled limestone becomes highly charged with siliceous material in the form of chert nodules while the limestone above changes from a mottled grayish-white with darker spots, to a uniform buff, less crystalline rock. The faunal change is not very marked, but it will be noticed that the numerous large cephalopods that characterize the lower are almost altogether wanting in the middle division. In addition to the lists given for characteristic fossils of each of the divisions, the following forms are found to be common to both, but do not extend above them:—*Protaræa vetusta* var. *magna*, *Liospira Americana*, *Endoceras (Nartheoceras) Simpsoni*, and *Poterioceras apertum*.

Arbitrary line
between two
lower
divisions

Upper Mottled limestone.

The most northerly exposure of this division is found in the cliffs on the western shore of the lake, north of the mouth of the Saskatchewan River. Here the beds are found to be highly dolomitic, and in consequence much harder than those of the same series in the south. The surfaces are found mottled in the same manner, and rough surface markings, as of fucoids, are also common on the bedding-planes. The volume of strata exposed is not very great, and the observed dip along the shore would seem to show that the total thickness here, thirty feet, would be shown on the cliff at the First Rocky Point. Probably a few feet of that from the south end of Selkirk Island should be added. On Selkirk Island, at the north end, a low cliff of hard dolomitic rock is found to contain a series of fossils similar in character to those found on the mainland, and is probably a continuation of these beds, while the highest rocks of this series in this locality are those at the southerly point of the island. There the rock is found very close-grained and hard or perhaps dolomitic. The colour is a dull-orange, and on glaciated or polished surfaces, a dark reddish-yellow. The few fossils brought from the locality, are badly preserved, but are mainly similar to those north.

Upper
Mottled
limestone.

Exposures on
north-western
shores of lake.

Section
north of
Saskatchewan
River.

Section of
division near
Clark Point.

These beds appear to dip slightly to the south-west, and are probably immediately overlain by the shales of the Stony Mountain formation, but no exposures are seen from here to the Saskatchewan. Farther to the south, the section is slightly different, the lower beds of the mottled limestones there resemble those to the north, but higher up in the section the beds become darker in colour, and are impure earthy limestones, evidently passing up into the shales of the Stony Mountain formation. These lower beds are to be found at a point about nine miles north from Clark Point, and at Dancing Point. The latter are almost the exact counterpart of the Selkirk Island beds, but southward become more impure and darker in colour. In the section north of Clark Point, it is found that at the base, there is a few feet of a cherty, yellow fine-grained limestone exposed, which approaches the character of the Cat Head rocks, but this is possibly a thin band of that character, here found higher than the top of the second division. The upper beds are similar to the Clark Point limestone, which appears to form the upper member of the series and might be termed transition beds. The section at Clark Point is mainly of a yellowish-gray limestone, with several shaly bands. The top beds are much softer and of a clayey nature, often so soft as to be easily broken by the fingers. Near the mouth of Dauphin River they again appear in low flat exposures, but at the foot of the rapids they are exposed in low cliffs on each side of the river. Although these beds show little change in the faunal conditions as compared with the beds below, they seem to form the extreme top of the limestone series, and it may be found subsequently that they should be included in the lower member of the Stony Mountain formation.

Transition
beds at
summit of
formation.

Beds of lower
part at Fisher
River.

On Fisher River the only beds seen, are near the mouth of the river and seem by their position, to be not far above the Cat Head, or near the base of the Upper Mottled limestones. They are light-coloured mottled limestone, very similar to that at East Selkirk. The mottling is in irregular patches of a light-brown, in a stone which is made up mainly of small calcite crystals and remains of shells, with fine chalk-like particles distributed freely throughout the mass. The stone is soft, breaking readily.

Exposures at
Selkirk.

The same characters are repeated in the rocks of East Selkirk and Lower Fort Garry. The beds at the Selkirk quarry are found in a broken state and are probably near the edge of a pre-glacial trough extending south from the present shore of the lake and since filled in by drift and river-deposit. No disturbance in the beds is seen at Lower Fort Garry. At West Selkirk the drift-deposit was found, in

drilling for a well, to extend to at least eighty feet below lake-level and the limestone is eroded to near the top of the Cat Head limestone. In the same drilling the base of these beds is supposed to be found eighty-eight feet deeper, and this thickness shows an increase of fifteen to eighteen feet over the sections on the lake, an increase which all the beds seem to receive south-westward from the outcrops. The measured section of the Lower Mottled limestone on the lake is here represented by eighty feet of limestone below what is taken as the base of the Cat Head limestone, showing an increase of about ten feet.

Increase in thickness of section westward.

The position then of the base of the Upper Mottled limestone would here appear to be one hundred feet below the top of the exposures at Lower Fort Garry and Selkirk. Of this thickness the upper part only, is exposed at the above localities, while of the lower part nothing is seen except what is probably represented by a few exposures near Fisher River.

Base of division ascertained at Selkirk.

From the depth at which the base of the limestone was found in the Selkirk well, in relation to the nearest known outcrop near Elk Island, the south-westward dip should be nearly the same as that at Grindstone Point. This dip will allow for the addition between Selkirk and Winnipeg of beds represented at Clark Point, probably the same as are shown at Bishop's quarry, near St. Andrews, where they are fine-grained, uniformly-coloured limestones. In estimating the total thickness of this division at one hundred and thirty feet, and adding below, that of the rock found in the well at Selkirk, we obtain two hundred and ninety-five feet as a total thickness for the Trenton. At Rosenfeld the measured thickness of this limestone band was three hundred and five feet, or slightly greater than to the north.

Thickness of division near Winnipeg.

In addition to the list already given, of fossils found in all three of the divisions of the Trenton, the following may be added as forms that are found as yet, in this upper division only :—

Fossils found in Upper Mottled limestone only.

Ischadites Iowensis, Owen.

Tetradium fibratum, Safford.

Diphyphyllum Stokesi, Edwards and Haime.

Pachydietya magnipora, Ulrich.

“ *acuta*, Hall.

Phylloporina Trentonensis, Nicholson.

Monticulipora Wetherbyi, Ulrich.

Mesotrypa Selkirkensis, Whiteaves.

Bythotrypa laxata, Ulrich.

Strophomema rugosa, Blainville.

- Strophomena Billingsii*, Winchell and Schuchert.
Rhynchonella Anticostiensis, Billings (variety).
Byssonychia intermedia, Meek and Worthen.
Modiolopsis angustifrons, Whiteaves.
Orthodesma affine, Whiteaves.
Conocardium antiquum, D. D. Owen.
Pleurotomaria Stokesiana, Whiteaves.
Eunema strigillatum, Salter.
Endoceras (Narthecoceras) crassiphonatum, Whiteaves.
Actinoceras Richardsonii, Stokes.
 " (*Deiroceras*) *Python*, Billings.
Orthoceras magnisulcatum, Billings.
 " *anellus*, Conrad.
Tripteroceras Lambii, Whiteaves.
 " *semiplanatum*, Whiteaves.
Oncoceras magnum, Whiteaves.
Aparchites Whiteavesii, Jones.
Calymene senaria, Owen.
Pterygometopus callicephalus, Hall.
Lichas (Platymetopus) cucullus, Meek and Worthen.
Lichas (Conolichas) cornutus, Clarke.

Stony Mountain formation.

Stony
Mountain
formation.

Character and
thickness of
Cincinnati
rocks.

The deposits lying between the top of the Trenton and the base of the Silurian, attain a great thickness in Eastern Canada and New York. Westward, however, they are found in diminishing thickness to Cincinnati, where they still exceed eight hundred feet. The subdivisions assigned to the eastern beds are recognizable there, but northward from Ohio, owing to a continued diminution in thickness, some of the subdivisions disappear. In Minnesota they are described as having a thickness of only seventy feet. The lower division of the Cincinnati rocks, the Utica, with a thickness of twenty feet, is there recognized, consisting mainly of thin-bedded limestones and shales. The central division, the Lorraine group, is not recognized, and the upper division is described as being similar to those of the Richmond group or upper part of the Cincinnati section, and consists of arenaceous and argillaceous limestones, mainly thin-bedded.

Although this formation is supposed to thin out altogether in northern Minnesota, there is found at Rosenfeld, in the southern part, of Manitoba, a great thickness of shale beds between limestone for-

mations which are probably Trenton and Silurian. At Stony Mountain, the section, although incomplete, in a known thickness below the Silurian of one hundred and ten feet, consists of shaly beds in the lower part with thick-bedded limestones above. The fossils from this part are mainly from the shaly beds below the limestone of the top of the section, and probably all these are collected from less than fifty feet below the top of the formation. We might infer from this that the upper part, that of which we have a section and a list of fossils, is referable to the Richmond group of Minnesota, and that the lower beds, mostly shales, are similar to the Utica of the Cincinnati formation. One species only, characteristic of the Utica of Minnesota has been found at Stony Mountain—*Primitiella unicorns*, Ulrich. The majority of those common to the two localities are from the upper parts of the sections. It is noted in the Minnesota reports that several forms occurring in the Trenton, appear in the Richmond group without any evidence of their presence in the Utica. The same might possibly be asserted of some of the Manitoba forms, as several are found to range from the Trenton to the Stony Mountain formation.

Thickness of section at Stony Mountain.

Age of beds.

The only outcrops in Manitoba of rocks of Cincinnati age, appear to be in the vicinity of Stony Mountain and Little Stony Mountain, but their presence elsewhere is proved by bore-holes, showing that they extend from Stonewall south-eastward to the vicinity of the city of Winnipeg. Their continuation southward probably occupies a band now heavily drift-covered, since their presence is demonstrated, as before noted, in the section drilled at Rosenfeld. Northward, no exposures are seen, the outcrop being hidden. The basin in which Lake St. Martin is situated is eroded through Silurian rocks, and it is found that the beds below belong probably to the Trenton, which lies on an elevation of the Archæan floor, as bosses of granite and trap protrude through. The Stony Mountain rocks are evidently here wanting, and if they outcrop northward the band is much thinner than to the south. At the Grand Rapids of the Saskatchewan the Silurian beds are found near the mouth of the river, and but a short distance eastward, the upper beds of the Trenton appear, so that the interval would allow of only a thin band to be interposed, but no outcrops of recognizable Stony Mountain formation are seen. A few beds near the mouth of the Warpath River appear to be above the Trenton and somewhat similar to the upper part of the Stony Mountain, but the absence of fossils leaves the age somewhat uncertain. Crossing the Little Saskatchewan River at Four-mile Rapid, Dr. Bell records shales holding *Rhynchonella capax*, but as this species is found

Distribution in Manitoba.

in the Trenton, the Stony Mountain age of these beds is also doubtful, since nearly similar rocks at the mouth of the river and at Clark Point have an extensive Trenton fauna.

Compilation
of list of
fossils.

A list of all the fossil forms so far obtained from the beds of Stony Mountain, as well as from the exposures of the Trenton and Black River of Lake Winnipeg, has been compiled from the palaeontological reports of the Survey and arranged in tabular form so as to show the horizon of their occurrence and give a comparative view of the fauna of the Cambro-Silurian of the Manitoba basin.*

LIST OF FOSSILS FROM THE CAMBRO-SILURIAN OF MANITOBA.

| | Passage beds at top of sandstone. | TRENTON (GALENA.) | | | RICHMOND GROUP. (Cin.) |
|--|-----------------------------------|--------------------------|---------------------|--------------------------|------------------------|
| | | Lower mottled limestone. | Cat Head limestone. | Upper mottled limestone. | Stony Mountain. |
| ALGÆ. | | | | | |
| <i>Licophycus Ottawaensis</i> , Billings..... | * | | | | |
| <i>Chondrites (Bythotrephis) patulus</i> , Whiteaves..... | | | | | |
| " <i>cuneatus</i> " | | | * | | |
| <i>Chondrites cupressinus</i> , Whiteaves..... | | | * | | |
| " <i>gracillimus</i> , Whiteaves..... | | | * | | |
| <i>Bythotrephis</i> (like <i>B. succulentus</i> , Hall)..... | | | | | * |
| RECEPTACULITIDÆ. | | | | | |
| <i>Receptaculites Oweni</i> , Hall..... | | * | | * | |
| <i>Ischadites Iowensis</i> , Owen..... | | | * | * | |
| <i>Pasceolus gregarius</i> , Billings..... | | | * | * | |
| PORIFERA. | | | | | |
| <i>Aulacopella Winnipegensis</i> , Rauff..... | | | * | | |
| <i>Trichospongia hystrix</i> , Whiteaves..... | | | * | | |
| CÆLENTERATA. | | | | | |
| Hydrozoa. | | | | | |
| <i>Climacograptus bicornis</i> , Hall..... | | * | | | |
| <i>Thamnograptus affinis</i> , Whiteaves..... | | | * | | |
| <i>Inocaulis Canadensis</i> , Whiteaves..... | | | * | * | |

*Palæozoic Fossils, vol. III., parts II. and III., by J. F. Whiteaves, F.G.S., F.R.S.C.

LIST OF FOSSILS FROM THE CAMBRO-SILURIAN OF MANITOBA.

| | Passage beds at top of sandstone. | TRENTON (GALENA.) | | | RICHMOND GROUP (CIN.) |
|--|-----------------------------------|--------------------------|---------------------|--------------------------|-----------------------|
| | | Lower Mottled limestone. | Car Head limestone. | Upper Mottled limestone. | |
| ACTINOZOA. | | | | | |
| Aleyonaria. | | | | | |
| <i>Halysites catenularia</i> , Linn, var. <i>gracilis</i> , Hall | | * | * | * | |
| <i>Tetradium fibratum</i> , Safford | | | | * | |
| Zoantharia. | | | | | |
| <i>Columnaria alveolata</i> , Goldfuss | | * | | * | |
| <i>Diphyphyllum Stokesi</i> , Edwards and Haime | | | | * | |
| <i>Streptelasma robustum</i> , Whiteaves | | * | | * | |
| " <i>rusticum</i> , Billings | | | | | * |
| " " var. <i>trilobatum</i> , Whiteaves | | | | | * |
| <i>Protarea vetusta</i> , Hall | | * | | | * |
| " " var. <i>ovigina</i> , Whiteaves | | * | * | | * |
| <i>Favosites prolificus</i> , Billings | | | | * | * |
| <i>Calaprecia Canadensis</i> , Billings | | * | | * | * |
| Hydromedusæ. | | | | | |
| <i>Beatricea undulata</i> , Billings | | | | | * |
| " <i>nodulosa</i> , Billings | | | | | * |
| Unclassified. | | | | | |
| <i>Solenopora compacta</i> , Billings | | * | | | |
| <i>Chætetes perantiquus</i> , Whiteaves | | * | | | |
| ECHINODERMATA. | | | | | |
| Crinoidea. | | | | | |
| <i>Glyptocrinus ramulosus</i> (?) Billings | | | | | * |
| " sp. undeterminable | * | * | * | | |
| Cystoidea. | | | | | |
| <i>Glyptocystites</i> , sp. undeterminable | | * | | | |
| Asteroidea. | | | | | |
| <i>Teniaster</i> , sp. undeterminable | | | * | | |
| VERMES. | | | | | |
| Annelida. | | | | | |
| <i>Serpulites dissolutus</i> , Billings | * | * | | | |
| <i>Arabellites</i> , sp. undeterminable | | * | | | |

LIST OF FOSSILS FROM THE CAMBRO-SILURIAN OF MANITOBA.

| | Passage beds at top of sandstone | TRENTON (GALENA.) | | | RICHMOND GROUP (CIN.) |
|--|----------------------------------|--------------------------|---------------------|--------------------------|---------------------------|
| | | Lower Mottled limestone. | Cap Head limestone. | Upper Mottled limestone. | Stony Mountain formation. |
| MOLLUSCOIDEA. | | | | | |
| Polyzoa. | | | | | |
| <i>Rhinidietya mutabilis</i> , Ulrich..... | * | | | | |
| " <i>obliqua</i> , Ulrich..... | * | | | | |
| <i>Echaropora ramosa</i> , Ulrich..... | | | | | |
| <i>Stomatopora Canadensis</i> , Whiteaves..... | | * | | | |
| <i>Proboscina autoporides</i> , Nicholson..... | | | | | * |
| " <i>frondosa</i> , Nicholson..... | | | | | * |
| <i>Monticulipora parasitica</i> , var. <i>plana</i> , Ulrich.. | | | | | * |
| <i>Homotrypa gracilis</i> , Nicholson..... | | | | | * |
| <i>Bythopora delicatula</i> , Nicholson..... | | | | | * |
| " <i>striata</i> , Ulrich..... | | | | | * |
| <i>Petiopora scabiosa</i> , Ulrich..... | | | | | * |
| <i>Monotrypa quadrata</i> , Rominger..... | | | | | * |
| <i>Batostoma Manitobense</i> , Ulrich..... | | | | | * |
| <i>Arthroctema angulare</i> , Ulrich..... | | | | | * |
| <i>Holopora Harrisii</i> , James..... | | | | | * |
| <i>Sceptopora facula</i> , Ulrich..... | | | | | * |
| <i>Ptilodictya Whiteavesii</i> , Ulrich..... | | | | | * |
| <i>Dicranopora fragilis</i> , Billings..... | | | | | * |
| " <i>emacrata</i> , Nicholson..... | | | | | * |
| <i>Goniotrypa bilateralis</i> , Ulrich..... | | | | | * |
| <i>Pachydietya hexagonalis</i> , Ulrich..... | | | | | * |
| " <i>magnipora</i> , Ulrich..... | | | | * | |
| " <i>acuta</i> , Hall..... | | | | * | |
| <i>Phylloporina Trentonensis</i> , Nicholson..... | | | | * | |
| " sp. undetermined..... | | | | * | |
| <i>Monticulipora Wetherbyi</i> , Ulrich..... | | | | * | |
| " <i>parasitica</i> var. <i>plana</i> , Ulrich..... | | | | * | |
| <i>Mesotrypa Selkirkensis</i> , Whiteaves..... | | | | * | |
| <i>Diptotrypa Westoni</i> , Ulrich..... | | * | | | |
| <i>Bythotrypa laxata</i> , Ulrich..... | | | | * | |
| Brachiopoda. | | | | | |
| <i>Lingula Iowensis</i> , Owen..... | | * | | | |
| " <i>elongata</i> , Hall..... | | | * | | |
| " <i>obtusa</i> , Hall..... | | | * | | |
| <i>Dinobolus parvus</i> , Whitfield..... | | | | * | * |
| " sp. undeterminable..... | | | | * | * |
| <i>Clitambonites diversa</i> , Shaler..... | | * | | | |
| <i>Anastrophia</i> (?) <i>hemiplicata</i> , Hall..... | | * | | | |
| <i>Strophomena incurvata</i> , Shepard..... | | | * | * | * |
| " <i>fluctuosa</i> , Billings..... | | | | * | * |
| " <i>rugosa</i> , Blainville..... | | | * | * | |
| " <i>trilobata</i> , Owen..... | * | * | * | * | |
| " <i>Billingsii</i> , Winchell and Schuchert..... | | | * | * | |
| <i>Rafinesquina deltoidea</i> , Conrad..... | | | * | | |
| " <i>Ceres</i> , Billings..... | | | * | | * |
| " <i>alternata</i> , Enmons..... | | * | * | | |
| " <i>Leda</i> , Billings..... | | * | | | |

LIST OF FOSSILS FROM THE CAMBRO-SILURIAN OF MANITOBA.

| | Passage beds at top of sandstone. | TRENTON (GALENA). | | | RICHMOND GROUP (Cin.) |
|---|-----------------------------------|--------------------------|---------------------|--------------------------|---------------------------|
| | | Lower Mottled limestone. | Cat Head limestone. | Upper Mottled limestone. | Stony Mountain formation. |
| MOLLUSCOIDEA—Con. | | | | | |
| Brachiopoda—Con. | | | | | |
| <i>Rafinesquina lata</i> , Whiteaves..... | | * | * | * | |
| <i>Leptaena uncostata</i> , M. & W..... | | | | | |
| " <i>nitens</i> , Billings..... | | | | | |
| <i>Plectambonites sciricea</i> , Sowerby..... | | | | | |
| <i>Orthis tricrenaria</i> , Conrad..... | | * | * | * | |
| " <i>pectinella</i> , Hall..... | | * | * | * | |
| " (<i>Linorthis</i>) <i>subquadrata</i> , Hall..... | | * | * | * | |
| " " <i>proavita</i> , W. & S..... | | * | * | * | |
| " (<i>Eulmanella</i>) <i>testudinaria</i> , Dalman..... | | * | * | * | |
| <i>Platystrophia biforata</i> , Schlotheim..... | | * | * | * | |
| " var. <i>crassa</i> , James..... | | * | * | * | |
| <i>Rhynchotrema cupax</i> , Conrad..... | | * | * | * | |
| " <i>inequivalvis</i> , Castelnau..... | | * | * | * | |
| <i>Rhynchonella Anticostiensis</i> , Billings..... | | * | * | * | |
| " " variety..... | | * | * | * | |
| <i>Zugospira recurvirostra</i> , Hall..... | | * | * | * | |
| <i>Cyclospira bisulcata</i> , Emmons..... | | * | * | * | |
| MOLLUSCA. | | | | | |
| Pelecypoda. | | | | | |
| <i>Byssonychia obesa</i> , Ulrich..... | | | | | * |
| " <i>intermedia</i> , M. & W..... | | | | * | |
| <i>Plethocardia</i> (sp. nov.)..... | | | | | * |
| <i>Pachyopteria parvula</i> , Whiteaves..... | | * | * | * | |
| <i>Modiolopsis parviuscula</i> , Billings..... | | * | * | * | |
| " <i>angustifrons</i> , Whiteaves..... | | * | * | * | |
| <i>Orthodesma affine</i> , Whiteaves..... | | * | * | * | |
| <i>Vanuxemia Hayniana</i> , Safford..... | | * | * | * | |
| <i>Ctenodonta astarteformis</i> , Salter..... | | * | * | * | |
| " <i>subaenata</i> , Ulrich..... | | * | * | * | |
| <i>Curtodonta Canadensis</i> , Billings..... | * | * | * | * | |
| <i>Clinopistha antiqua</i> , Whiteaves..... | | * | * | * | |
| <i>Rhytimya recta</i> , Whiteaves..... | | * | * | * | |
| <i>Conocardium antiquum</i> , D. D. Owen..... | | * | * | * | |
| <i>Edmondia vetusta</i> , Whiteaves..... | | * | * | * | |
| Gasteropoda. | | | | | |
| <i>Tetranota bidorsata</i> , Hall..... | | * | * | * | |
| <i>Salpingostoma Buellii</i> , Whitfield..... | | * | * | * | |
| <i>Conradella</i> , sp. uncertain..... | | * | * | * | |
| <i>Pleurotomaria bicincta</i> , Hall..... | | * | * | * | |
| " <i>muralis</i> , D. D. Owen..... | | * | * | * | |
| " <i>acuta</i> (?) Sowerby..... | | * | * | * | |
| " <i>Stokesiana</i> , Whiteaves..... | | * | * | * | |
| " <i>margaritoides</i> , Whiteaves..... | | * | * | * | |

LIST OF FOSSILS FROM THE CAMBRO-SILURIAN OF MANITOBA.

| | Passage beds at top of sandstone. | TRENTON (GALENA.) | | | RICHMOND GROUP. (Cin.) |
|--|-----------------------------------|--------------------------|-----------------------|--------------------------|------------------------------------|
| | | Lower Mottled limestone. | Cat Head lime-stones. | Upper Mottled limestone. | Stony Mem- bran forma- tion. |
| MOLLUSCA— <i>Con.</i> | | | | | |
| Gasteropods:— <i>Con.</i> | | | | | |
| <i>Liospira Americana</i> , Billings..... | | * | * | | |
| " <i>persimilis</i> , Ulrich and Scofield..... | | | * | | |
| " <i>angustata</i> , Ulrich and Scofield..... | | | * | | |
| <i>Hormotomo gracilis</i> , Hall..... | | * | | | * |
| " <i>Winnipegensis</i> , Whiteaves..... | | * | | | |
| <i>Murchisoni bellicineta</i> , Hall..... | | * | | | |
| <i>Solenospira pagoda</i> , (Salter), var. <i>occidentalis</i> , Whiteaves..... | | | | | |
| <i>Bellerophon bilobatus</i> , Sowerby..... | | | | | * |
| <i>Cyrtolites compressus</i> , Conrad..... | | | | * | * |
| <i>Cyclora minuta</i> , Hall..... | | | | * | |
| <i>Maclurea (Maclurina) Manitobensis</i> , Whiteaves..... | | * | * | * | * |
| <i>Trochonema umbilicatum</i> , Hall..... | | | * | * | * |
| " <i>eccentricum</i> , U. & S..... | | | * | | |
| " <i>niota</i> , Hall..... | | * | | | |
| <i>Eunema strigillatum</i> , Salter..... | | | | * | |
| <i>Subulites</i> , sp. undetermined..... | | | | * | |
| <i>Fusispira inflata</i> , M. & W..... | | * | | * | |
| " <i>elongata</i> , Hall..... | | * | | * | |
| <i>Loxonema Winnipegense</i> , Whiteaves..... | | * | | | |
| PTEROPODA. | | | | | |
| <i>Conularia asperata</i> | | * | * | | |
| " sp. undetermined..... | | * | | | |
| CEPHALOPODA. | | | | | |
| <i>Endoceras subannulatum</i> , Whitfield..... | | * | * | * | |
| " (<i>Nartheoceras</i>) <i>crassisiphonatum</i> , Whiteaves..... | | | * | * | |
| " " <i>Simpsoni</i> , Billings..... | | * | * | | |
| <i>Actinoceras Richardsonii</i> , Stokes..... | | * | * | * | |
| " <i>Bigsbyi</i> , (?) Bronn..... | | * | * | * | |
| " <i>Altumettense</i> , Billings..... | | * | * | * | |
| " (<i>Deioceras</i>) <i>Python</i> , Billings..... | | * | * | * | |
| " (<i>Sactoceras</i> ?) <i>Canadense</i> , Whiteaves..... | | * | * | * | |
| <i>Orthoceras Winnipegense</i> , Whiteaves..... | | * | * | * | |
| " <i>magnisulcatum</i> , Billings..... | | * | * | * | |
| " <i>Selkirkense</i> , Whiteaves..... | | * | * | * | * |
| " <i>anellus</i> , Conrad..... | | * | * | * | * |
| <i>Tripteroceras Lambii</i> , Whiteaves..... | | * | * | * | * |
| " <i>semitplanatum</i> , Whiteaves..... | | * | * | * | * |
| <i>Asoceras costulatum</i> , Whiteaves..... | | * | * | * | * |
| " sp. undetermined..... | | * | * | * | * |
| <i>Poterioceras nobile</i> , Whiteaves..... | | * | * | * | * |
| " <i>apertum</i> , Whiteaves..... | | * | * | * | * |

DESCRIPTIVE GEOLOGY.

TRENTON PERIOD.

Winnipeg sandstones and shales.

Sandstone
near Elk
Island.

The first exposures of the Winnipeg sandstone on the southern part of the lake, in Traverse Bay, on the eastern side of the Elk Island peninsula, have been described by Mr. Tyrrell. They are on section 36, Tp. 19, R. VII, where the banks rise to a height of thirty feet. His notes are as follows:—'The top, for about six feet, is composed of a sandy till, with large and small boulders, having the appearance of a ground moraine. Lying unconformably below this is a soft light-gray or brown sandstone, generally rather fine and arenaceous, but in places coarse, and fairly evenly bedded throughout. The exact thickness of this was not seen, but it would appear to extend down to the water. This cliff extends along the shore for about half a mile.'

Elk Island.

Other exposures are noted on the north-west shore of Elk Island. The following note refers to a point about midway along the face of this island:—'Bank fifty feet high (measured). From thirty to forty feet is seen to be composed of fine white sand, while the upper five feet is of stratified sand and pebbles, evidently alluvial. The rest of the bank is covered with slidden material. The fine white sand which is thinly and horizontally bedded is doubtless the Winnipeg sandstone. This is seen in many small exposures on the face of the slide-covered cliff, and is composed of interstratified white and light-brown, soft, clayey sandstone.'

Outlier on
Clement Point

A small outlier is also recorded by Mr. Tyrrell on Clement Point, or on the northern shore of the bay at the mouth of Bad-throat River.

Black Island.

The shores of Black Island afford many sections which are recorded in his field-notes. From a perusal of his descriptions of the shores of this island it is seen that the Winnipeg sandstones occupy nearly the whole of the island, with the exception of a small area at the eastern end. The Trenton limestone possibly forms a thin covering for the greater part, as occasional slabs are found on the beach. Sections showing the presence of sandstone, occur on both sides of the island. The section which shows probably the lowest beds occurs on the north side, about three and a half miles from the eastern end and is as follows:—

'The shore is sandy, with many boulders, among which are many small rounded fragments of coarse granular or vesicular iron-ore. At this spot is a very interesting section from the surface downward as follows:—

| | Feet. | Inches. |
|--|-------|---------|
| Yellow and red ferruginous swamp-deposit containing <i>Planorbis parvulus</i> , etc..... | 1 | 0 |
| Horizontally stratified and undisturbed, blue-gray clay, without pebbles..... | 3 | 0 |
| Very much disturbed clay, part being well stratified. At the bottom tongues of sand run up into it, and it is underlain by the same sand. Both sand and clay contain pebbles.... | 2 | 0 |
| Covered..... | 3 | 0 |
| Horizontally stratified white or light-yellow soft sandstone of moderately even grain. | | |
| In a few yards the clay and pebbles shown above run out and the whole is replaced by soft white horizontally bedded sandstone | 12 | 0 |
| | 21 | 0 |

'Just east of the point this is seen to be underlain by harder, yellow, very coarse sand or fine conglomerate.'

On the south side of the island, almost directly across, another section is exposed, in which thirty-one feet of sandstone is seen. At about the middle of the south side, to the east of the iron-ore deposit, the following section is recorded:—

| | Feet. | Inches. |
|---|-------|---------|
| Surface deposit | 2 | 0 |
| Rounded gravel..... | 0 | 6 |
| Till, differing little from the sandstone below, except that the bedding in places is destroyed and it is filled with pebbles and boulders..... | 8 | 0 |
| Soft white or light-yellow sandstone.... | 3 | 0 |
| Moderately hard white sand, the surface of which is weathered and very soft | 15 | 0 |
| Covered, to water edge..... | 15 | 0 |
| | 43 | 6 |

On the north shore, to the east of the mining claim laid out there, about midway along the shore, but nearer the eastern end of the island, the following section is noted:—

'The cliff behind, which is higher than that farther east, is here thirty feet high and is composed as far as can be seen of light-yellow and white, soft sandstone in horizontal beds, capped by a few feet of mixed up sandstone containing boulders. Sandstone is also seen along the edge of the water, thus giving in all a thickness of about twenty-five feet.'

Section on
north shore
Black Island.

Section on
south side.

Exposures on
north shore.

Erosion of
channel
through
sandstone.

The shore in view of Gull Harbour on Big Island, affords many examples of small exposures of the soft sandstones. None of them seem to be of great thickness, and the probability is that the base of the Trenton is not far above lake-level, and that the strait between the two islands, which is eroded to such a great depth, mainly by current action, is through the soft sandstones. The depth, forty-two feet, may be through the greater part of the section here, though toward the eastern end of Black Island, the surface, back from the shore, rises to ninety feet, and is probably all sandstone with a light cap of limestone. The only section showing the limestone in place capping the sandstone, is at a point one mile from the south-west point on the south shore. The section recorded in Mr. Tyrrell's notes is as follows:—

| | Feet. | Inches. |
|--|-------|---------|
| Section of sandstones near western point. | | |
| Gray, mottled Trenton limestone in thick beds, somewhat shidden but evidently in place | 4 | 0 |
| A little soft gray sand is stuck to the bottom corner of the limestone slabs. | | |
| Covered | 8 | 0 |
| Dark bottle-green soft earthy shale containing near the top concretionary masses of hard clear quartzose sand. | 4 | 0 |
| Soft brown sand .. | 0 | 9 |
| Blue sandy clay | 0 | 1 |
| White or light-green hard sandstone, much broken, weathering light-yellow and smelling strongly of sulphur, in places tinted brown with iron | 3 | 0 |
| Soft, light-blue sandy clay | 0 | 11 |
| Thick-bedded sandstone, brown and hard enough to break off in pieces but the bottom part soft and white | 6 | 0 |
| Covered, to water | 14 | 0 |
| | 40 | 9 |

Two hundred yards farther east similar sandstones are seen extending down to within six feet of the edge of the water.

Sandstone on
Big Island.

On the northern end of Big Island the sandstones are exposed just below the limestone bed, but the face of the exposure is generally covered by debris, so that the section can not be given in detail. The height of the dividing line between the two formations, was found to be at twenty-five feet above the water. Owing to a dip to the south-west, these beds are not again exposed on this island.

Deer Island.

The exposures on Deer Island are best seen on the northern face, but as the eastern side was visited by Prof. H. Y. Hind, the exposures there seen will be described first. On the eastern face of the north-east point, there is a sloping exposure of sandstone and shale, showing the following beds in ascending order:—At the beach there is about three feet of soft sandstone, the hardest in the exposure.

This is in beds eighteen to twenty inches in thickness, the colour is generally light, but a good deal stained with iron—exposed surfaces weathering dull brown. Above this, for fifteen feet, are thin streaky beds of sandstone, separated by shale, generally green and black, giving the whole a mottled look—a mixture of yellow, red, green and white. All these shales and sandstones crumble in the hand, having little consistency, and grade upward into darker beds with less sand and more shale, forming a band of five feet of dark shaly beds. Above the dark band, purer sand-beds with little shale, have a thickness of seven feet, making in this exposure a section in all of about twenty-eight feet. About the middle of the north-eastern shore, the soft sandstones of the upper part are all denuded away, leaving only the lower harder beds. By a slight flexure in the rocks, these lower beds are raised three or four feet, so that six or seven feet in all are there exposed, and some large blocks have been quarried out for building purposes. Owing to the softness and uncertain strength of this stone, none of it seems to have been used, moreover, the rusty streaks, caused by the decomposition of the pyrites often contained, renders it unsightly. The preservation of animal remains has been very imperfect, but on some surfaces a few impressions as of lamellibranchs are seen. Branching stems, or forms resembling plants, are very abundant in nearly all the beds.

Section on
north-eastern
face.

Quarry.

At the northern point there is the same section slightly modified and with an addition of about fifteen feet of limestone lying conformably on the sandstone. The section near the point is as follows:—Fifteen feet of thick-bedded limestone splitting into rectangular slabs from one to six inches in thickness, lying upon about five feet of a yellow friable sandstone in rather thin beds. Below this the beds get thinner and the shaly partings give them a darker appearance. The section described by Prof. H. Y. Hind in 1859, must have been of the cliff at or near this point. His description which is very minute, is as follows:—*

Section at
northern point

Section
recorded by
H. Y. Hind.

‘Lake-level.

‘Shingle Beach, (Limestone.)

‘No. 1. Four feet of dark-green argillo-arenaceous shale, with thin layers of sandstone of uneven thickness—Fucoids very abundant in the sandstone. The weathered sandstone is reddish-brown; fresh surfaces are white or gray. White iron-pyrites assimilating the forms of disks, spheroids and shells occurs in the sandstone.

‘No. 2. In many respects like the former; the sandstone layers are from one to four inches in thickness and predominate over the shaly

* Report of the Saskatchewan Exploring Expedition by H. Y. Hind, M.A., p. 86.

Section by
H. Y. Hind.

portions. Its thickness is six feet. The character of these formations (1 and 2) is very variable; the green argillaceous portion sometimes predominates, and occasionally the sandstone.

'No. 3. Ten feet of sandstone with green bands of a soft argillaceous rock, from one quarter to four inches in thickness. The sandstone is often white, but generally red. A persistent green band, a few inches thick, filled with obscure forms, resembling fucoids is very characteristic. The red coloured sandstone is often soft and friable, the white frequently embodied in the red. Both red and white, contain obscure organic forms. The green patches which are found throughout the sandstone, contain impressions of fucoids; an *Orthoceratite* was found in the sandstone. In some parts of the exposure on Deer Island the sandstone layers are much harder, although partaking of the characters already described. When thus hard, the white portion is extremely brilliant, of a pure white, and very siliceous, it would form an excellent material for the manufacture of glass. Forms coloured brown, often pervade the white sandstone, and appear to resemble fucoids and corals replaced by brown ochreous sand.

'No. 4. Eighteen feet of limestone, perfectly horizontal, very hard and breaking off the cliff where the soft sandstone has been weathered away, in huge rhomboidal slabs, eight to twenty-five feet in diameter and four to ten inches thick.'

North-west-
ern face of
Deer Island.

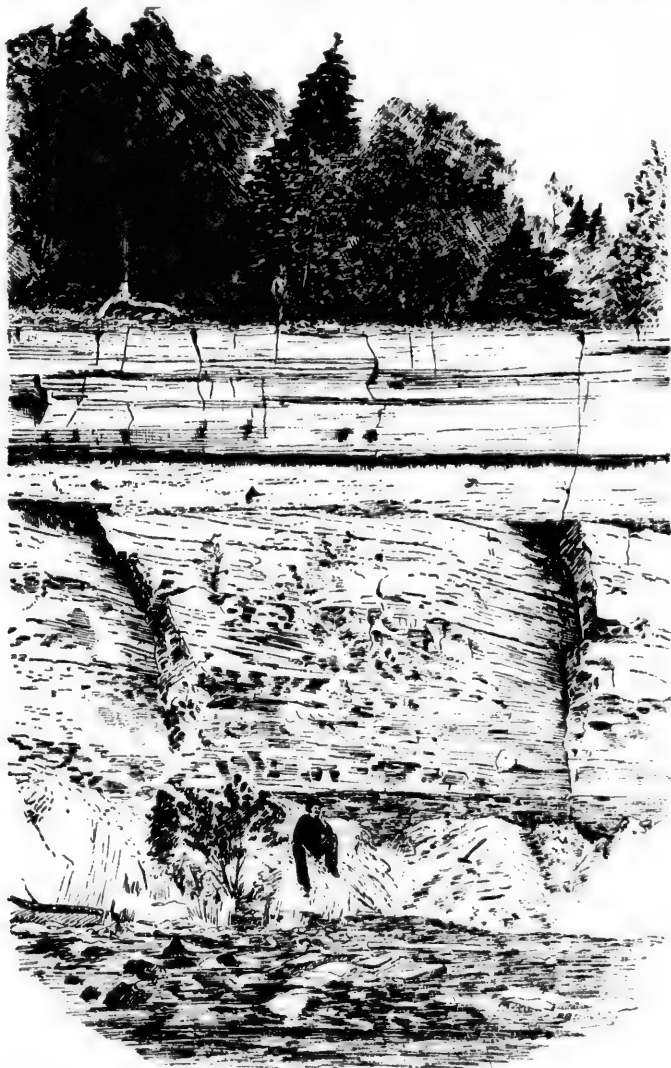
The north-western face of the island is by far the most interesting as it is quite free from detrital material, the cliff being precipitous and showing a good section to the top of the beach. The limestone capping it, is as before noted, about eighteen feet thick at the northern point, but thins somewhat to the south-west, showing less than ten feet of beds at the western end. This has been caused by the denudation of some of the upper beds.

Section on
north side.

About the middle of the exposure where a section was measured, the thickness is ten feet. Below this a bed of yellow sandstone, very friable, three feet in thickness, lies horizontal and perfectly conformable to the limestone. Below this, false-bedding gives an appearance of unconformity. The beds dip away quite sensibly to the south-west. They are thin and of a yellow sandstone, with traces of shaly partings. Each bed dips away from the upper horizontal line, making an angle with it of from eight to ten degrees. Following a bed downward, it thins out gradually and the dip becomes less, so as to form a slight curve, and when it has descended about seventeen feet, it has about regained the horizontal position.

This thinning out without loss of shale, results in a series of thin-bedded shaly sandstones, two or three feet answering well the description by Hind of No. 2. The upper part contains less shale and shaly

Section on
north side
Deer Island.



SECTION ON DEER ISLAND, SHOWING FALSE BEDDING IN SANDSTONE.

Section on
north side
Deer Island.

bands, than described by Hind, and is no doubt due to a slight change in these false-bedded bands farther north along the section. Hind's section was observed at the northern end of the island, at nearly right-angles to this one, and would consequently not show the false-bedding. Here the proportion of shale increases from the top. The general colour of the lower half of the section is a dark-yellow, with streaks of red, blue and green. Above, it is of a lighter yellow, with a few rusty spots and small patches weathered ashy white, fresh fractures appearing less stained with red, and of a light chrome-yellow. At the base of this sandstone are two feet of a dark shale with sandy streaks. The shale is green or black. It is all soft, easily crumbled in the hand, and is in no part free from sand. A thin bed of dark sandstone, averaging a foot in thickness lies below. This is a harder bed than any in the section above, except the limestone, but it is, still a soft sandstone. Dark sandy shales again appear, adding about three feet more to the section.

The top was forty-one feet six inches above lake-level, in September, 1891-bottom of limestone and top of sandstone thirty-one feet six inches-bottom of three-foot bed of sandstone, and top of false-bedding, twenty-eight feet six inches. False-bedding extends down for about seventeen feet, and at a point eleven feet six inches above lake-level, has about regained the horizontal stratification of the upper beds. About nine feet six inches above water, the shaly beds overlie a sandstone layer of varying thickness. The top of the beach averages four feet six inches above the lake.

The shore facing the south-west shows no exposure of this sandstone. On the small island to the west, sandstone and shales are exposed, with a predominant green colour. This is evidently the same as the lower part of the section just described, the beds being here nearly horizontal.

Fossils.

Fossils collected from the sandstones of Deer Island :—*Licrophycus Ottawaensis*, *Serpulites dissolutus*, *Rhimidictya mutabilis*, *Escharopora ramosa*, *Strophomena trilobata*, *Orthis testudinaria*, and *Conularia* (sp. undeterminable).

Punk Island.

On Punk Island the total thickness of this sandstone is nearly one hundred feet. The western half of the island is capped by the limestone, as on Deer Island, dipping to the south-west, forming a sloping plane, broken on its eastern edge by the denudation of the limestone. The eastern part, being made up almost wholly of the sandstone, is irregular and at a lower level. At the eastern end, the sandstone is found resting on the Archean. No actual contact is seen, but the

small islands immediately off the point, are found to be Huronian. The sandstone here is generally light coloured and very friable, but sometimes are darkly stained with iron, presumably from deposits of iron-ore, immediately beneath. The exposures on the north side are mostly covered by great slabs of limestone, fallen from above, but in the shaly beds many fossil forms were collected. Among the more common the following forms were identified by Dr. Whiteaves:—*Licrophycus Ottawaensis*, *Glyptocrinus* (sp. idnt.), *Serpulites dissolutus* (sp. indt.), and a *Conularia*.

On the mainland to the north, this sandstone underlies the points on the western side of the lake to near Dog Head.

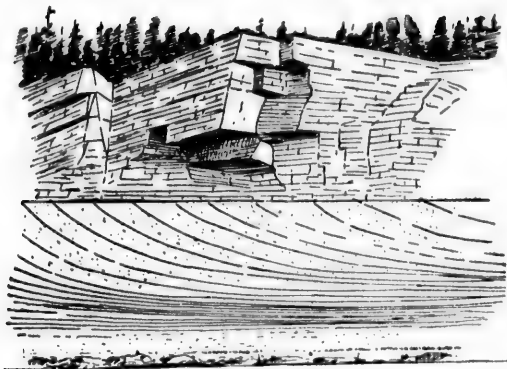
At Little Grindstone Point the overlying limestone is at an elevation of about seven feet above the water, so that very little of the sandstone is seen. The section observed consisted of two feet of fucoidal sandstone, showing above the beach. Indications of fossils are seen in this, and from a few loose blocks of the lowest bed several specimens of *Cyrtodonta Canadensis* were collected. The upper part of the section consists of eighteen inches of thin-bedded sandstone and shales immediately below the limestone.

The exposure eastward to Grindstone Point continues to increase in height, and at the extreme point the following descending section was measured:—

| | Feet. | Inches. |
|--|-------|---------|
| Limestone, dark, mottled..... | 5 | 6 |
| Yellow friable sandstone..... | 2 | 5 |
| Greenish sandy shale..... | 2 | 0 |
| Soft yellow sandstone | 4 | 0 |
| A series of thin beds of sandstone averaging 2 in. with shaly partings, giving the whole a variegated appearance, colours green, yellow and white..... | 10 | 0 |
| Soft sandstone, full of small nodules of harder rock, stains rusty red..... | 13 | 0 |
| Dark sandy shale, green brown and red..... | 1 | 0 |
| Dark-brown ferruginous sandstone harder than any above..... | 3 | 0 |
| At water's edge, light-yellow sandstone harder than in section above. | — | — |
| | 40 | 11 |

From this exposure of thirty-five feet of sandstone a few fossil forms have been collected. Dr. Whiteaves recognizes the following:—*Licrophycus Ottawaensis*, *Glyptocrinus*, and *Cyrtodonta Canadensis*.

Westward along the north side of the point, the section resembles that of the north side of Deer Island, but the false-bedding noted there, is continued to the top of the sandstone in the Grindstone Point exposure, as shown in the cut on next page.



SKETCH-SECTION ON NORTH SIDE OF GRINDSTONE POINT; LIMESTONE BEDS RESTING ON FALSE-BEDDED SANDSTONE.

Sandstone
exposed near
Bull Head.

On the north side of Washow Bay, these sandstones are exposed in several places from near Little Bull Head northward. The exposure at Little Bull Head, three miles south of Bull Head, is at the base of a high escarpment rising sixty feet above the lake, showing limestone at the top. Débris covers the face to about twenty-five feet from the water-line, where two feet of blue and green shales lie on the top of thick sandstone beds. The upper bed is marked by numerous harder portions resembling the fucoid impressions common in the limestones above. Red and yellow sandstones, very friable, occupy the rest of the section. The top of the fucoidal sandstone bed is here twenty-two feet above the water, and is again seen near Bull Head at eight feet, and within half a mile of Bull Head at five feet above the lake. The limestone resting on these soft rocks is broken by vertical cleavage-planes, and sometimes displaced, but the base would appear to be at about nineteen feet above the fucoidal bed, making with the section at Little Bull Head a thickness here exposed of about forty-one feet.

Fissures in
limestone.

Following the shore northward to Dog Head, there is abundant evidence that the limestone exposed all along, rests on these very soft beds. Everywhere great blocks are broken off and have partially slid down toward the water. An estimate can be occasionally had of the thickness of the limestone exposed, so that the surface plane of the sandstone is estimated to lower to the north until it reaches the water-level near Dog Head.



SECTION ACROSS CHANNEL AT DOG HEAD.

A section, made by soundings, shows a probability of there being Thickness of about one hundred feet of soft beds below the limestone, resting on the section at sloping floor of the Archean rocks. Dog Head.

Lower Mottled limestone.

The lower beds of the Trenton are exposed along the eastern edge of the outcrop of the Cambro-Silurian in this basin, from Berens Island southward to Elk Island and the peninsula south of it. Drift-deposits seem to cover the outcrop farther south. Owing to the friable nature of the lower beds, an enormous amount of material has been moved and appears as surface deposits. In the vicinity of Elk Island and on Black Island, the boulder-clay is covered to a height, in many instances, of upwards of fifty feet by lacustral sandy deposits, and these are sometimes difficult to distinguish from the Winnipeg sandstones. Mr. Tyrrell records in sections 15 and 16, Tp. 20, R. VII., many large slabs of mottled limestone strewn along the shore, and on the southwest end of Elk Island, a low cliff having twelve feet exposed of the mottled limestone of the lower part of the Trenton.

On Black Island the only exposure of beds in place is in the section already quoted in the descriptions of the Winnipeg sandstone, in which four feet of limestone is seen. The presence of this bed capping the sandstones composing the main part of the island is shown by the finding of limestone slabs at various points along the shore, reaching on the south side to past the centre of the island. On the north shore limestone boulders were found only a short distance from the strait separating the two large islands.

The rocks exposed on Big Island are everywhere thin-bedded, dark earthy-yellow, mottled limestone, weathering lighter in colour. It is immediately above the sandstone which is exposed on the islands to the north, and a small exposure is seen at the extreme northern point. This is a small cliff of ten feet of limestone overlying sandstone of

Lower
Mottled
limestone of
Big Island.

which but little can be seen, the face of the lower part of the exposure being covered with debris. Above the limestone cliff is exposed a section of reassorted boulder-clay and gravel, but from the limestone a number of fossils have been collected, of which Dr. Whiteaves determines the following:—

Receptaculites Oweni, Hall.

Orthis tricenaria, Conrad.

Maclurea Manitobensis, Whiteaves.

Fusispira inflata, Meek and Worthen.

Cyrtoceras Manitobense, Whiteaves.

Exposures on
south-east
shore of
Big Island.

These beds are not seen in Gull Harbour to the south-east, but reappear farther south along the eastern shore and form cliffs as far as Hecla P.O. Owing to the slight dip to the south-west, they gradually pass below the lake before the southern end of the island is reached. A nearly continuous cliff extends from near Gull Harbour to the boundary between townships 24 and 25. This is of an average height of twelve feet, showing very nearly the same beds in its entire length. Toward the northern end it is more broken, and has evidently settled down owing to the denudation of the softer beds beneath, by the strong current through the narrows. The height of the base of the limestone, at a distance of only three miles eastward on Black Island, is thirty-five feet above water-level, while on this part of Big Island it is apparently below it.

At Hecla P.O. the exposure is of twelve feet of limestone, reaching to the water's edge, containing an abundance of such fossil forms as *Maclurea Manitobensis*, a large *Hormotoma* and occasionally *Endoceras subannulatum*. The weathered surface is light-gray with yellow markings, but on fresh fracture the colour is darker.

On the western side of the island the exposures are few, if any, but on the two northern points limestone is seen. The extreme north-eastern one has already been described. This exposure continues south-westward for about a mile. Across a bay opening toward Deer Island another exposure is seen. Here the lowest bed of limestone is near lake-level, and about twelve feet of similar limestone is shown, apparently the same beds as at Hecla P.O.

Deer Island.

Above the sandstone exposures on Deer Island, there is a capping of ten feet of limestone overlying a sandstone bed, quite conformable with it, and above the false bedding shown in the sketch. The characters of this stone need not be described in detail, as there is a great similarity

between all these exposures. From this locality a number of fossil forms have been collected of which the following is a list:—

Fossils from
Deer Island.

- Streptelasma robustum*, Whiteaves.
Calapœcia Canadensis, Billings.
Glyptocystites, sp. undeterminable.
Diplotrypa Westoni, Ulrich.
Anastrophia hemiplicata, Hall.
Strophomena trilobata, Owen.
Rafinesquina Leda, Billings.
Maclurea Manitobensis, Whiteaves.
Fusispira inflata, Meek & Worthen.
Cyrtoceras Manitobense, Whiteaves.
Harpes, sp. undeterminable.

The limestone exposed on Punk Island is of the same character, and on the north side, it is seen broken up in thin slabs sliding down the face of the exposure.

From Little Grindstone Point eastward, blocks are strewn along the face of the sandstone cliff and almost completely hide it, while above, the beds are seen in place, but separated in large masses by vertical cleavage planes. These beds, owing to the yielding nature of those underlying them, easily tip outward, and sliding on one another, cause a vast amount of loose material to be accumulated. In a few of the beds, are seen what appear to be sections of the body-chamber of a large species of *Gomphoceras* cutting them at right angles. These, when broken out of a thin bed, produce circular discs, somewhat resembling a grindstone, and may be the character which is indicated in the name given to the extremity of the point.

South side
Grindstone
Point.

Grindstones.

At Grindstone Point there is only five feet and a half of the Lower Mottled limestone exposed, but farther south-west, more beds are seen above. Near this point, on the south side, the stone has been burnt for lime, and two kilns are still to be seen, though they have not been in operation for a considerable period. The lime burned is said to have been of excellent quality, but the difficulty of shipment by the lake, caused the suspension of operations.

Lime-kilns

The elevations of the lowest bed above the water, between Grindstone Point and Little Grindstone Point, show a uniform dip south-westward, and from a height of forty feet six inches, at the former place, it has fallen to six feet at the latter, showing a dip of thirty-four feet in six miles and a half along the shore, but, if measured with the full dip, it amounts to about eight feet per mile. The beds continue exposed

Dip of beds.

for about a mile farther, and it is evident that additional exposures are not to be expected, as the plane sinks below the water, while the higher beds seem to have been denuded away, leaving low shores for a long distance southward. The exposures of Grindstone Point are continued westward to the entrance to Washow Bay, and from ten to fifteen feet of strata are exposed.

Bull Head.

The next exposure is on the north side of Washow Bay, and is continuous to Dog Head. The extremity of the point at Bull Head is composed of broken masses of limestone and boulder-clay, forming a small plateau about twenty feet high, extending northward from the higher escarpment of the shore to the south and west. The clay exposed on the eastern side is slightly stratified in the upper part of the section, and the blocks of limestone, which form part of the cliff, are evidently transported a very short distance, from their size and angular form. About half a mile to the south, beds, apparently in place, though probably slidden down somewhat, show nineteen feet of thin-bedded, mottled limestone similar to the Deer Island exposures. Another exposure near the last, shows the limestone in thin layers. The colour is a light-gray, spotted with dark-yellow, but the lower beds are darker and not so mottled with yellow, and seem to contain dark, earthy matter. On the surface they are weathered a rusty-yellow, common to upper and lower beds alike.

Little Bull Head.

Three miles south of Bull Head, the escarpment reaches its maximum height of sixty feet above the water, showing only about nine feet of limestone above an exposure of sandstone beds, previously described (p. 62 F). This broken cliff extends southward to a point about eight miles from Bull Head, and is there seen with the limestone much lower down—about three or four feet above the water. From the nature of the exposure the exact point at which the lowest bed should reach lake-level, is hard to find, but it would be not far from the southern end of the cliff. Broken masses of limestone strew the shore all along the face of the exposure, and indicate the presence of the rock in place in many instances where it is hidden by a dense growth of trees.

Western cliffs at the Narrows.

The Narrows between Bull Head and Dog Head show the near approach of the Cambro-Silurian deposits to the eastern shore. The section made at Dog Head suggests that, underlying the limestone, there is possibly one hundred feet of soft beds. The eastern shore is of Archæan gneiss and granite, forming a fairly straight and high shore. The west side is bold but deeply and irregularly indented, leaving several high points between the bays. One of more prominence than

the rest is called Limestone Cave Point, from the immense fissures in the cliff behind the beach, sometimes forming galleries, as described by H. Y. Hind. This structure is not confined to the above point, but is found all along this shore, and is due to the yielding nature of the underlying rock.

From Dog Head, south for two miles, the limestone is exposed in a broken cliff consisting of pillars and blocks standing back from the beach. They have all been tipped out from their original position in the cliff. The true section can only be measured in crevices back from the outer face. The beds here exposed are summarized in the following descending section:—

| | Feet. | Inches. |
|---|-------|---------|
| Light-yellow limestone, with darker yellow spots, forming about 20 per cent of the mass | | 0 |
| Dark-yellow beds of similar character to those above, except that the dark spots form 50 per cent of the mass. | 5 | 0 |

When this rock is exposed, it weathers light-yellow with rusty markings—the same in character as that on Snake Island and the main-land opposite; but, in these large crevices, samples broken off show this light colour to be on the surface only and the original colour to be a dark grayish-yellow in a mass almost bluish. Small grains of pyrites are seen through it, and help to give the exposed surface a rusty appearance. The beds are all very similar but with a darkening in colour in the lower part of the section. The thickness of the beds varies from one to two feet.

The height of the exposures rises toward the south, and at Limestone Cave Point, that of the top bed is forty-eight feet above the lake, or about twenty feet higher than Dog Head. On the shore are seen slabs and pebbles of limestone with a few large blocks that have slidden down. Behind this the slope is irregular, being formed of large blocks, partly concealed by forest, scrub and moss, and separated by wide, deep fissures with steep rocky sides. The vertical jointage is here roughly east-and-west, and north-east and south-west; so that the lines of fractures are roughly parallel to the shores. The beds exposed in these fissures are not shattered and seem to be of a thickness varying from two to six feet, with thinner ones showing at the bottom of the fissure. This broken cliff extends at practically the same level for two miles south, where, in a deep crevice, twenty-three feet of beds were measured. Large blocks have slidden bodily down to the shore, and form an irregular wall; giving an appearance as of a low exposure of limestone, with the top at about fifteen feet above lake, whereas,

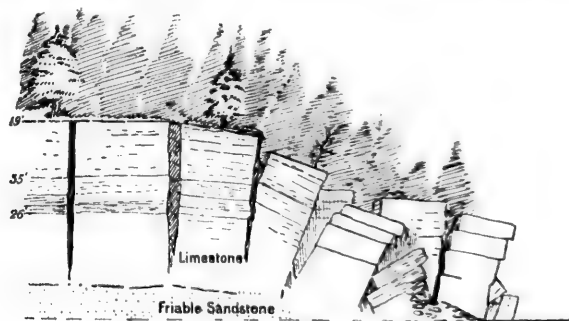
Limestone Cave Point.

Section south of Dog Head.

Slope of surface of limestone.

Broken cliffs.

Broken cliffs, concealed by the trees, the solid cliff stands at nearly fifty feet high. A section sketched at this point is here reproduced.



SECTION AT LIMESTONE CAVE POINT.

Boucher Point.

The next point south, Boucher Point, is of a similar nature, though not so high; the cliff rising forty-four feet and showing sixteen feet of limestone beds. These are thin-bedded, and split easily into slabs and flags. Other exposures are found across the bay to the south, where the top of the limestone is thirty-one feet eight inches above the lake and ten feet six inches of beds are exposed. At the water's edge a bed of sandstone similar to that at Bull Head is seen.

North shore at Dog Head.

The cliff at Dog Head is continued along the north shore to near Snake Island. About twelve feet only is exposed at the point, and the beds are thin or broken, of a yellowish colour, with dark-brownish spots or stains, causing the whole to be evenly mottled. The principal fossils noticed are *Endoceras subannulatum*, *Maclurea Manitobensis*, and *Receptaculites Oweni*. The cliff, though broken, shows occasionally a good section in the crevices back from the face. Nearly two miles westward, the section measured in descending order is as follows:—

| | Feet. | Inches. |
|--|-------|---------|
| 1. Thinly-laminated beds of spotted limestone | 7 | 0 |
| 2. Evenly-grained limestone, with a few dark spots | 1 | 0 |
| 3. Soft, spotted limestone, breaking into thin slabs and irregular nodules | 2 | 8 |
| 4. Dark, earthy-limestone, spotted | | 2 |
| 5. Two beds similar to No. 2 | 6 | 0 |
| | 16 | 10 |

One mile and a half farther west, No. 4 is a foot and the top of No. 2, four feet seven inches above the water, showing a dip in this direc-

tion of five feet two inches, or three feet four inches in the mile. The North shore cliff there shows an addition of five feet at the top, of beds similar to at Dog Head. No. 1.

One mile west a small exposure shows No. 2 at the water's edge. This increases the dip to four feet seven inches in the mile.

Opposite the southern end of Snake Island, ten feet of limestone similar to No. 1, is seen very much broken into lumpy fragments. Following the same dip with that given by the last two sections, the present one would add four feet to the top beds or, roughly, along this shore, about twenty-five feet of the Lower Mottled limestone is exposed in all.

Low boulder-strewn shores extend westward with no definite exposure of rock in place, to the point west of Moose Creek, where limestone débris indicates the proximity of beds probably below the water level. These may be slightly higher than any seen in the foregoing sections.

The following fossils have been collected from the exposures at Grindstone Point, Bull Head and Dog Head, and represent a similar horizon to that of Big Island and Deer Island, the lowest of the mottled limestones :—

- Pasceolus gregarius*, Billings.
Halysites catenularia, L., var. *gracilis*, Hall.
Streptelasma robustum, Whiteaves.
Calapecia Canadensis, Billings.
Glyptocystites, sp. undeterminable.
Lingula Iowensis, Owen.
Clitambonites diversa, Shaler.
Strophomena trilobata, Owen.
Plectambonites sericea, Sowerby.
Platystrophia bifurcata, Schlotheim.
Rhynchotrema capax, Conrad.
Pleurotomaria muralis, D. D. Owen.
Liospira Americana, Billings.
Hormotoma Winnipegensis, Whiteaves.
Maclurea Manitobensis, Whiteaves.
Trochonema umbilicatum, Hall.
 “ *niota*, Hall.
Fusispira inflata, Meek and Worthen.
Loxonema Winnipegense, Whiteaves.
Endoceras subannulatum, Whitfield.
 “ *Simpsoni*, Billings.

List of fossils.

Inches.

0

0

8

2

0

10

top of No.
this direc-

Poterioceras apertum, Whiteaves.
Oncoceras Whiteavesii, Miller.
Cyrtoceras Manitobense, Whiteaves.
Trochoceras McCharlesii, Whiteaves.
Asaphus maximus, Locke

Black Bear
Island.

On Black Bear Island the beds exposed are of the same horizon with those at Dog Head. The lower sandstone is not seen, and is probably several feet below the lake. Thirty feet of limestone is exposed in one cliff on the eastern side of the island. The upper ten feet is of mottled buff colour, and fewer fossils are found in it than in the lower beds. Toward the centre of the island the upper beds have been removed, and the surface is lowered, sloping toward the south-west. The exposures on the north and west side are of the same beds, which appear to be nearly horizontal.

Fossils collected are determined by Dr. Whiteaves to be of the following species :—

Receptaculites Oweni, Hall.
Halysites catenularia L., var. *gracilis*, Hall.
Fusispira inflata, Meek and Worthen.
Endoceras subannulatum, Whitfield.
Actinoceras Allumettense, Billings.
Illeenus Americanus, Billings.

Snake Island.

On Snake Island a cliff of the same limestone is found, exposing about ten feet of beds. The following fossils were collected here :—

Fossils:

Streptelasma robustum, Whiteaves.
Strophomena trilobata, Owen.
Plectambonites sericea, Sowerby.
Orthis subquadrata, Hall.
Platystrophia bifurcata, Schloth., var. *crassa*, James.
Hormotoma gracilis, Hall.
Maclurea Manitobensis, Whiteaves.
Trochonema umbilicatum, Hall.
Fusispira inflata, Meek and Worthen.
Endoceras subannulatum, Whitfield.
 “ *Simpsoni*, Billings.

Little Tamarack
Island.

Beds very similar and possibly an upward continuation of the ones seen on Black Bear Island, are exposed on Little Tamarack Island about eight miles to the north-west. A low cliff runs along the north shore, composed of eleven feet of thin-bedded limestone of the same mottled character. The fossils procured there belong to the following species :—

Halysites catenularia, *Streptelasma robustum*, *Strophomena trilobata*, *Vanuxemia* sp. indt., *Hormotoma Winnipegensis*, *Oncoceras Whiteavesii*, and *Illanus Americanus*.

In following these beds northward, the next exposures are found on Commissioner and Berens Islands, though probably at low water some of the bars north of Egg Island may also show them. On Commissioner Island one exposure is known at the north-east point. This shows only a couple of feet of beds of thin, mottled limestone, forming a long bar or point at the east side of Commissioner Harbour. A great similarity between these beds and the lower ones of Dog Head was noticed. Fossils belonging to the following species were collected here:—*Halysites catenularia*, *Salpingostoma Buellii*, *Liospira Americana*, *Hormotoma Winnipegensis*, *Maclurea Manitobensis*, *Trochonema umbilicatum*, *Fusispira inflata*, *Endoceras subannulatum*, *Endoceras Simpsoni*, *Potrioceras nobile*, *Oncoceras Whiteavesii*, *Cyrtoceras laticurvatum*, and *Discoceras Canadense*.

Several exposures on the eastern side of Berens Island are of similar beds to the limestone of Commissioner Island, and are probably just above them in the section. The first locality noted was a low, shelving exposure south of a bay on the east side. The beds there are thin, with fucoidal markings or casts, having a grayish-yellow colour mottled with dark rusty-yellow spots. Northward, the shore trends to the north-east, and at its extreme eastern extension limestone beds are exposed near the water for some distance along the shore, and fragments from these beds have furnished material for a high gravel-beach. The character of the rock is similar to that last noted. Other exposures probably occur on the shoals lying off this point toward Flat Head. On the northern shore low exposures are again seen, and all the beds exposed on the island are practically the same. A few fossils were collected, mostly cephalopods, among which were *Actinoceras Canadense* and *Potrioceras nobile*.

Beds similar to those on Little Tamarack Island are exposed on Little Black Island just west of Berens Island. These are above the beds shown on the latter island, and form a cliff fourteen feet high, on the north side. The beds are thin and the face of the cliff is broken or shattered so that it resembles exposures of the upper beds west of Dog Head. The stone is light yellowish-gray, mottled by darker or orange markings. The list of fossils from this locality, is more complete than from any other at which these beds have been examined. It is made up from the determinations by Dr. Whiteaves of specimens

Fossils from
Little Black
Island.

brought in by Mr. J. B. Tyrrell in 1889, and by Messrs. D. B. Dowling and L. M. Lambe in 1890.

- Receptaculites Oweni*, Hall.
Halysites catenularia, L., var. *gracilis*, Hall.
Streptelasma robustum, Whiteaves.
Protarcea vetusta, Hall.
 " " var. *magna*, Whiteaves.
Arabellites, sp. undeterminable.
Stomatopora Canadensis, Whiteaves.
Orthis subquadrata, Hall.
Platystrophia bifurcata, Schloth., var. *crassa*, James.
Hormotoma Winnipegensis, Whiteaves.
Solenospira pagoda, Salter var. *occidentalis*, Whiteaves.
Maclurea Manitobensis, Whiteaves.
Trochonema umbilicatum, Hall.
Fusispira inflata, Meek and Worthen.
Loxonema Winnipegense, Whiteaves.
Endoceras subannulatum, Whitfield.
 " *Simpsoni*, Billings.
Actinoceras Bigsbyi, Brown.
 " *Canadense*, Whiteaves.
Orthoceras Winnipegense, Whiteaves.
Ascoceras costulatum, Whiteaves.
Poterioceras gracile, Whiteaves.
Oncoceras magnum, var. *intermedium*, Whiteaves.
 " *Whiteavesii*, Miller.
Cyrtoceras laticurvatum, Whiteaves.
Eurystomites plicatus, Whiteaves.
Discoceras Canadense, Whiteaves.
Trochoceras McCharlesii, Whiteaves.
Aparchites Whiteavesii, Jones.
Asaphus Susæ, Whitfield.
Bumastus Trentonensis, Clarke.

Jack Head
Island.

The highest member of the Lower Mottled limestone is that exposed on Jack Head Island lying to the west of Little Tamarack Island. From the eastern point, which is piled high with limestone gravel, numerous small exposures of limestone are seen along the north and western shores. Flat-lying rock is exposed to the east near the water's edge and six feet above this or at the top of the beach-ridge three feet more of the same rock is seen in a small cliff. This is of a hard, mottled limestone of a dark-yellow colour with brownish-yellow

markings, breaking up into lumpy fragments. The beach, which is Jack Head made up of this rock, consists of irregularly shaped fragments not Island. weathering into discoidal forms. At the northern point there is an



SHATTERED BEDS OF THE LOWER MOTTLED LIMESTONE, JACK HEAD ISLAND.

exposure of fifteen feet of these beds in a vertical cliff, showing the mottled beds at the base with thin-bedded and more evenly coloured ones at the top. These top beds approach in character those classed in the next division as the Cat Head limestone, and are the highest seen on the lake, of the lowest division of the limestones. The fossils collected are referred to the following species by Dr. Whiteaves:—

Fossils from
Jack Head
Island.

- Pasceolus gregarius*, Billings.
- Halysites catenularia* L., var. *gracilis*, Hall.
- Columnaria alveolata*, Goldfuss.
- Streptelasma robustum*, Whiteaves.
- Strophomena trilobata*, Owen.
- Rafinesquina lata*, White.
- Hormotoma Winnipegensis*, Whiteaves.
- Maclurea Manitobensis*, Whiteaves.
- Loxonema Winnipegense*, Whiteaves.
- Endoceras subannulatum*, Whitfield.
- Oncoceras Whiteavesii*, Miller.
- Cyrtoceras Manitobense*, Whiteaves.
- “ *laticurvatum*, Whiteaves.

Cat Head limestone.

Above the series described as the Lower Mottled limestone, are cream-coloured dolomitic limestones of a general even colour and texture and rather fine-grained, in which are found numerous nodules of chert of varying sizes. The exposures of these beds are seen in greatest thickness along the northern sides of Cat Head and McBeth Point, and are continued westward to Lynx Bay. At the western end or near the entrance to Lynx Bay, the cliff is twenty-five feet from the top bed to water-level. The lower part, seven feet, is a soft, even-grained, yellow dolomitic limestone followed by two feet of the same regular fine-grained stone, but containing large concretions of cherty matter which seem to have had some influence in breaking up the beds. The lines of fracture run outward from the nodules as though from the effect of an expansive force. One kidney-shaped nodule, the largest in the cliff, measured two feet long and eight or ten inches in depth. Above this broken band is three feet of beds of yellow limestone, succeeded by another broken band of three feet, containing also many large nodules. Many of these suggest sponges or corals from their shape at least, but no structure was noted in them. The upper beds are not so cherty, and the top one is covered on the upper surface by rough raised fucoidal markings, though not accompanied by a mottling in colour as in similarly marked beds in the divisions above and below. Towards the east the broken bands vary, and are less distinguishable from the rest of the section, and at Cat Head the lower twenty-seven feet, which seems to be of the same rock, has become evenly spotted with small cherty concretions, and the beds are not so irregularly broken up. The upper part of the section there, shows nearly twenty feet of thick beds of yellow, granular, dolomitic limestone, weathering rough and honey combed. One bed of two feet and a half in thickness, the top of which is forty feet from the water, shows a much more marked fucoidal structure, the softer spots easily weathering away, leaving a very rough face. There is no marked distinction between the contiguous beds, but the rock from the upper part can easily be separated from that of the middle of the section. A correlation of beds in different exposures is difficult. The beds at the top, or at an elevation of twenty-five feet above the lake, two miles west, seem to correspond with those at about twenty-eight feet at Cat Head, showing a dip west of only three or four feet in two miles. This dip must increase westward or these beds would be seen at Clark Point, where much newer ones occur.

Cat Head

The extreme end of Cat Head is an overhanging cliff with the base exposed to the denuding agency of the waves, and in consequence large

blocks frequently fall. But they seem to be easily broken up and the debris is swept into the bay to the east, forming a high gravel-ridge around the bay and out to a former island, the northern end of which is McBeth Point. Here is a small cliff of the same dolomitic limestone with cherty nodules, showing about twelve feet of beds. They are easily split into thin slabs, and from these at various times a large collection of fossil remains have been collected. The following list, combined with those from Inmost Island, may be taken as forming a fairly complete series from this division.

List of fossils from the Cat Head limestone, at McBeth Point:— List of fossils.

Chondrites cuneatus, Whiteaves.

“ *cupressinus*, Whiteaves.

Aulacopella Winnipegensis, Whiteaves.

Trichospongia hystrix, Whiteaves.

Thamnograptus affinis, Whiteaves.

Inocaulis Canadensis, Whiteaves.

Halysites catenularia L., var. *gracilis*, Hall.

Glyptocrinus, sp. undeterminable.

Taniaster, sp. undeterminable.

Lingula obtusa, Hall.

Strophomena incurvata, Shepard.

Rafinesquina lata, Whiteaves.

Leptæna unicostata, Meek and Worthen.

Orthis tricenaria, Conrad.

Rhynchotrema inequivalvis, Castelneau.

Ctenodonta subnasuta, Ulrich.

Liospira Americana, Billings.

Maclurea Manitobensis, Whiteaves.

Conularia asperata, Billings.

Endoceras subannulatum, Whitfield.

“ *Simpsoni*, Billings.

Poterioceras apertum, Whiteaves.

Asaphus gigas, De Kay.

“ *maximus*, Locke.

At the south-east side of the entrance to Kinnow Bay, exposures of Inmost Island. thin-bedded, fine-grained, dolomitic limestone, are seen on an island lying near the shore. This is Birch or Inmost Island, and the rocks exposed are probably not far below those of Cat Head. These are probably the lowest of this division seen on the lake, and there is probably a gap between them and the upper ones of Jack Head Island. The list of fossils found at this island contains many found at McBeth Point,

but also adds many not found elsewhere. It may be here remarked that the state of preservation in which these are found enabled Dr Whiteaves to identify more varieties than was possible in many of the specimens from other exposures.

Fossils.

List of fossils from Inmost Island :—

- Chondrites patulus*, Whiteaves.
 “ *gracillimus*, Whiteaves.
Pasceolus gregarius, Billings.
Inocaulis Canadensis, Whiteaves.
Glyptocrinus, sp. undeterminable.
Lingula elongata, Hall.
Strophomena incurvata, Shepard.
Rafinesquina deltoidea, Conrad.
 “ *alternata*, Emmons.
Leptæna unicastata, Meek and Worthen.
Plectambonites sericea, Sowerby.
Orthis tricenaria, Conrad.
Zygospira recurvirostra, Hall.
Palæopteria parvula, Whiteaves.
Clinopistha antiqua, Whiteaves.
Edmondia vetusta, Whiteaves.
Tetranota bidorsata, Hall.
Pleurotomaria margaritoides, Whiteaves.
Liospira Americana, Billings.
 “ *angustata*, Ulrich and Scofield.
Maclurea Manitobensis, Whiteaves.
Conularia asperata, Billings.
Oncoceras Whiteavesii, Miller.
Asaphus Susæ, Whitfield.
 “ *gigas*, De Kay.
Ilænus Americanus, Billings.
Bronteus lunatus, Billings.

Outer
Sturgeon
Island.

Exposures on the north side of Outer Sturgeon Island, north of Saskatchewan Point, are of beds which belong to this division, and are probably of the upper part. On the northern point, a lot of loose limestone blocks are lying on the face of a low exposure of horizontal beds of a hard, semi-crystalline, dolomitic limestone. The lower beds are close grained, somewhat similar to the Cat Head rock and contain many nodules of chert. Above is a semi-crystalline limestone, in some of the beds resembling a sandstone, but generally composed of fragments of shells. Of this there is six feet. Four feet of thinner beds

are on the top and are seen to contain few traces of fossil remains. The broken material from this cliff has been carried partly round the island in both directions, forming high gravel beaches and bars. That to the south-west, forms a long bar extending nearly half a mile from the island, though part of the material for it, is derived from shelving rock not far below water-level. The fossils collected from this exposure consist of the following species:—*Strophomena incurvata*, *Zygospira recurvirostra*, *Otenodonta astartiformis*, *Maclurea Manitobensis*, *Conularia asperata*, *Endoceras subannulatum*, *Actinoceras Richardsonii*, and *Cheirurus pleurexanthemus*.

Outer
Sturgeon
Island.

Fossils.

Among the St. Martin Islands, no exposures of rock in place were seen on those visited, but loose rock, in the form of high gravel-beaches, having the same character as the beds above described, is a common feature, and it is supposed that the surface of the beds may be just under the lake-level. On Reindeer Island no exposures are seen, but the same loose rock was also noted, though toward the northern end, loose blocks of the Lower Mottled limestone were seen in the boulder-clay.

St. Martin
and Reindeer
Islands.

The Cat Head limestone is exposed at Howell and Robinson points, on the west shore, north of Selkirk Island. The cliffs there are mainly of the Upper Mottled limestone, but the lower bed is of the fine-grained, dolomitic limestone, such as characterizes the Cat Head beds and represent the highest rock of this division seen on the lake. A few feet only is there exposed near the water-line, and it is quite possible that the whole thickness of the division is much less than at Cat Head.

North of
Saskatchewan
River.

Upper Mottled limestone.

The exposures in the valley of the Red River, below Winnipeg, are all of a light-yellowish mottled limestone familiar to the residents as the building stone used in Winnipeg from the quarries at East Selkirk. This is a soft limestone, containing about seventeen per cent of carbonate of magnesia, and seventy-eight to eighty-two per cent of carbonate of lime. The colour is a light cream, mottled with dark-yellow to brown, spots or irregular markings. The stone dresses easily, and also burns to a very good lime.

Characters.

On the Red River, exposures are not frequent. Low shelving limestone crosses the river at St. Andrews, but very little is exposed, being covered for the most part by drift.

Lower Fort
Garry.

At the Stone Fort, or Lower Fort Garry, an exposure of eight to ten feet of limestone in horizontal beds is seen on the western bank, near the mouth of a small stream entering above the fort. This exposure was noted by Major Long during his expedition to the sources of the St. Peter River in 1823, but no fossils were found in it, and the first discovery of the fossiliferous character seems to have been made by D. D. Owen in 1848. He also noted the dolomitic character of the rock and published two analyses which are given below* :—

Analyses of
limestone.‘Compact limestone containing *Leptæna*.

| | |
|--|-------------|
| Carbonate of lime..... | 53.7 |
| Carbonate of magnesia..... | 40.5 |
| Insoluble matter..... | .8 |
| Alumina, oxide of iron and magnesia..... | 4.0 |
| Water, and loss..... | 1.0 |
| | <hr/> 100.0 |

‘Spotted and banded limestone from Red River containing *Coscino-
pora sulcata*.

| | |
|---|-------------|
| Carbonate of lime..... | 78.1 |
| Carbonate of magnesia..... | 17.8 |
| Insoluble matter..... | 1.0 |
| Alumina, oxide of iron and manganese..... | 1.4 |
| Water and loss..... | 1.7 |
| | <hr/> 100.0 |

Buildings
constructed.

This has long been quarried for making lime and for building stone. The walls of the fort and warehouses have been built from stone obtained from this vicinity, and stone was also quarried here for the asylum at Selkirk during the winter of 1883-84. The character of the stone is that of a soft mottled limestone, white and brownish, dressing easily, and similar to that of East Selkirk. Dr. Whiteaves, in vol. III., part III., Palæozoic Fossils, discusses the collections of fossils previously made at this locality, and mentions this as the first locality at which fossils were found in these limestones. The following list is compiled from the above report, and probably includes all the well identified species collected to date.

Fossils.

Receptaculites Oweni, Hall.
Ischadites Iowensis, Owen.
Pasceolus gregarius, Billings.
Halysites catenularia, L., var. *gracilis*, Hall.
Columnaria alveolata, Goldfuss.
Diphyphyllum Stokesi, Edwards and Haime.
Streptelasma robustum, Whiteaves.

* Report by D. D. Owen on Geology of Wisconsin, Iowa and Minnesota, 1852, p. 181.

Fossils from
East Selkirk.

- Protarua vetusta*, var. *magna*, Whiteaves.
Favosites prolificus, Billings.
Calapercia Canadensis, Billings.
Pachydictya magnipora, Ulrich.
 " *acuta*, Hall.
Phylloporina Trentonensis, Nicholson.
Monticulipora Wetherbyi, Ulrich.
Bythotrypa laxata, Ulrich.
Strophomena incurvata, Shepard.
 " *rugosa*, Blainville.
Rafinesquina alternata, Emmons.
 " *lata*, Whiteaves.
Leptæna unicosata, Meek and Worthen.
Plectambonites sericea, Sowerby.
Orthis testudinaria, Dalman.
Platystrophia bifurcata, Schlotheim.
Rhynchotrema inequivalvis, Castelneau.
Byssonychia intermedia, Meek and Worthen.
Modiolopsis angustifrons, Whiteaves.
Conocardium antiquum, D. D. Owen.
Salpingostoma Buellii, Whitfield.
Conradella, sp. uncertain.
Pleurotomaria muralis, D. D. Owen.
Trochonema umbilicatum, Hall.
Eunema strigillatum, Salter.
Fusispira inflata, Meek and Worthen.
 " *elongata*, Hall.
Endoceras subannulatum, Whitfield.
 " *crassiphonatum*, Whiteaves.
Actinoceras Richardsonii, Stokes.
 " *Bigsbyi*, Brown.
 " *Allumettense*, Billings.
Tripteroceras semiplanatum, Whiteaves.
Poterioceras nobile, Whiteaves.
Aparchites Whiteavesii, Jones.
Calymene senaria, Owen.
Asaphus Susa, Whitfield.
Ilænus Americanus, Billings.
Bumastus Trentonensis, Clarke.
Cheirurus pleurexanthemus, Green.
Stanocephalus, sp. undeterminable.
Lichas cucullus, Meek and Worthen.
 " *cornutus*, Clarke.

At East Selkirk there are two exposures, one on the banks of Cooks Creek, to the west of the station, and the other to the south and across the creek. The first has not been used extensively as a quarry, owing to the depth of loose material above the rock. The second is on higher ground, and the rock is, as far as seen, in large loose blocks, though some of it may be in place. The following description of the quarry by the late Prof. J. Heyes Panton is very graphic and full :*—

Quarry at
East Selkirk.

‘The exposure is not very extensive as yet, the quarry being opened but a comparatively short time. As you approach this place from the station you perceive that there is a slight elevation, well defined in the vicinity of the outcrop. Looking at the face of the rock you observe that the strata are covered with about four feet of loose drift in the southern part, but full ten in the northern. In this are numerous boulders, a few gneissoid, but most of them the same material as the solid rock, and of a more or less angular nature. The strata on the east side is quite horizontal, but on the west very much tilted. There appears to be a break through the centre of the quarry, indicating a marked upheaval at one time. * * * On the west side there are immense fragments, lying at an angle of 45° with vacant spaces like caves below them. From the raised appearance of this part it seems as if the apparent mound over the quarry has had its origin in this upheaval.

‘Fossils appear after the first layer of rock is removed. No part of the quarry as yet seems more prolific than another. The layers of rock are about two feet thick and exposed to a depth of about twelve feet. Neither from personal observation nor from questioning the workmen have I been able to ascertain that certain fossils characterize particular beds. The most casual observer could not fail to observe the fossils on the stones of this place. Remains of cephalopods, corals and the genus *receptaculites* are seen on every side, the last being exceedingly common. The cephalopods are numerous and large—several five to seven inches in diameter have been observed.

‘The rock from this place is largely used in Winnipeg for ornamental stone. Being comparatively soft it dresses readily and takes a good finish, and when burnt produces a very white lime. It is of a grayish-white colour, and effervesces strongly on treatment with cold hydrochloric acid. It presents a peculiar mottled-like appearance which adds much to its beauty as an ornamental stone. This strange mixture of brown and white is difficult to account for. In some cases it appears as if its origin might be due to seaweed re-

*Transaction No. 15, Man. His. and Ge. Soc., Winnipeg, 1884.

mains. Often the coloured portion approaches the colour of yellow ochre, and seems strongly impregnated with iron, while the intervening spaces are more or less coloured. So marked is this mottled condition that the stone from Selkirk district can be distinguished at once from the rock described in a subsequent part of this paper.' Selkirk quarry.

Mr. Tyrrell's notes contain also a description and as it is later, it shows some features not disclosed before. The following is the extract: 'It [the quarry] is a pit on the west side of a small knol cut down to a depth of about twelve feet. The exposed face runs S. 35° E., and the north end of the exposure consists of horizontal thick-bedded limestone for seven feet, overlain by five feet of till or, boulder-clay, consisting of white clay holding fragments of limestone lying in every direction. The surface of the limestone under this very irregular till, is rough, not being scored or polished. The southern portion of the exposure consists of large irregular masses of limestone, lying in all directions, between which, the spaces are packed with smaller masses and white clay, often with a few pebbles and small boulders of the Archean rocks. This has evidently been a pre-glacial hill of limestone, and the glacier from the north-east has broken off the upper portion and shoved it down as a tail-deposit behind. Near the station, only a few hundred yards away, it is necessary to dig about thirty feet to the limestone rock.' Tyrrell's description.

Many fine specimens of fossils have been obtained here by officers of the Geological Survey, and others, notably Mr. A. McCharles and Prof. Pantou, have contributed to the collection now in the Geological Survey Museum. The following list is compiled from Dr. Whiteaves's report and contain the names of specimens obtained from all sources: Collections of fossils.

List of fossils from East Selkirk :—

- Receptaculites Oweni*, Hall.
- Halysites catenularia*, L., var. *gracilis*, Hall.
- Tetradium fibratum*, Safford.
- Columnaria alveolata*, Goldfuss.
- Streptelasma robustum*, Whiteaves.
- Favosites prolificus*, Billings.
- Calapæcia Canadensis*, Billings.
- Mesotrypa Selkirkensis*, Whiteaves.
- Strophomena incurvata*, Shepherd.
- " *trilobata*, Owen.
- Rafinesquina alternata*, Emmons.
- " *lata*, Whiteaves.
- Maclurea Manitobensis*, Whiteaves.

List of fossils.

Fossils from
Selkirk.

Endoceras subannulatum, Whitfield.
 " *scrassisiphonatum*, Whiteaves.
Actinoceras Richardsonii, Stokes.
 " *Bigsbyi*, Bronn.
Orthoceras magnisulcatum, Billings.
 " *Selkirkense*, Whiteaves.
Tripteroceras Lambii, Whiteaves.
Poterioceras nobile, Whiteaves.
Oncoceras magnum, Whiteaves.
Trochoceras McCharlesii, Whiteaves.
Asaphus Susæ, Whitfield.
Ilænus Americanus, Billings.
Bumastus Trentonensis, Clarke.
Pterygomotopus callicephalus, Hall.
Cheirurus pleurexanthemus, Green.
Staurocephalus, sp. undeterminable.

The presence of carbonate of magnesia in this stone is shown in the subjoined analysis and is practically the same as that found by D. D. Owen in the spotted and banded limestone at Lower Fort Garry.

Analysis of building stone from quarry at East Selkirk.*

Analysis of
building stone

'Specific gravity, (temp. 60° F.) 2.7025. Weight of one cubic foot, (calculated from specific gravity) 168.9 pounds.

'Absorbing power—(the numbers represent the absorption obtained by the aid of the air-pump).

'Water absorbed, per cent, 3.471. Weight of water absorbed by one cubic foot of the rock, 5.86 lbs.

'After drying at 100° C., its composition was found, by Mr. F. D. Adams, to be as follows:—

| | |
|-------------------------------|--------|
| Carbonate of lime..... | 82.612 |
| Carbonate of magnesia..... | 16.322 |
| Ferric oxide and alumina..... | 0.302 |
| Silica (dissolved)..... | 0.032 |
| Insoluble matter..... | 0.913 |

100.781

Another exposure of these beds is described by Mr. A. McCharles as being on Sec. 6, Tp. 13, R. VI. east, about five miles to the south-east of Selkirk Station. 'There is a natural exposure of similar strata in two small hopper shaped holes close to each other at the junction of a low marsh with one of the gravel ridges that are so common in that

* Report of Progress for 1882-84, p. 1, part M.M.

locality. The stone is thinner-bedded, and therefore broken into smaller blocks than at the Selkirk quarries, though otherwise the same in every respect. But this outcrop is seldom worked, as it is usually under water in ordinary seasons.*

It is impossible to judge the exact position of these with relation to the Selkirk beds, but they may be lower. The beds at Lower Fort Garry are of about the same horizon as those at Selkirk.

On the lake northwards, similar beds were seen at the mission on Fisher River, but the fossil remains found were of an obscure nature and only one, *Actinoceras Bigsbyi* can be definitely determined. This has also been found at Lower Fort Garry and East Selkirk and ranges down through the lower divisions. The exposure there is in the bed of the river at the first rapids. It shows two feet of a soft fragmental rock containing small crystals of calcite and white streaks from the remains of shells, &c.

Yellow spots give it the same mottled appearance, and in hardness it closely resembles the Selkirk stone. The rock contains many softer pulverulent portions. To some extent the same is the case with the Selkirk stone. A few fossils not identified were a valve of a large brachiopod and a coiled cephalopod.

One mile south from the mission, a ridge elevated four or five feet above the general surface, is covered with slabs and loose blocks of limestone. They appear to be derived from beds below, but may have been moved a short distance. The absence of other varieties of limestone seems to point to their being near the parent beds. The slabs are of a dark-yellow granular limestone with many cavities partly filled with a light, ochreous powder. A few fossil brachiopods and a branching coral something like *Diphyphyllum Stokesi* are found in this rock, which, if in place, must be at least eight feet above the whitish limestone in Fisher River.

In the northern part of the lake, there are beds which are considered to be of the same horizon as those of Selkirk, but their characters are varied. The mottled parts are rather darker in colour and much harder, and the thickness of the division is much reduced. Above these and apparently just below the Stony Mountain shales, are much darker beds with several clayey layers.

Other exposures are seen at Dancing Point, where a low cliff shows four feet and a half above the water, extending 100 yards along the

* Transaction No. 27. Hist. & Sc. Soc. of Man., Winnipeg, 1887.

Dancing Point shore. The beds are about horizontal, and the surface forms a flat table, which has been somewhat smoothed by glacial action and shows a few striae. This rock is a dark, semi-crystalline, dolomitic limestone rather harder than that at Selkirk. A few badly preserved fossils were obtained here, including *Streptelasma robustum* and *Orthis proavita*.

Carscallen Point. Opposite the St. Martin Islands, at Carscallen Point, are several exposures of beds which possibly occur just above the Dancing Point rock. They are of a soft impure limestone, dull yellowish-gray, and semi-crystalline, in beds from two to three feet thick, but splitting up into thin flags. The thickness exposed in the bay to the north of the point is eleven feet ten inches. Under this is a fine-grained yellow limestone, the upper part evidently fragmental—a few inches of a thin bed at the top being a conglomerate with rounded pebbles of the same material as the matrix, though not of as dark a colour. Of these fine-grained beds there is about two feet three inches shown above the water. The stone breaks readily with a smooth fracture and on a weathered surface the conglomeritic nature of the upper part is strongly shown.

This exposure is on a slight anticline which brings up the yellow beds at the centre. On the point the beds exposed are practically the same as those in the bay noted above. They dip slightly to the west, and at the water-line another bed of the fine-grained limestone is exposed, in which are seen some obscure fossils. In the upper part the conglomeritic band does not show in as marked a manner as at the last exposure. The upper part of the section consists of the dark-yellow semi-crystalline rock noted above. Of this there is a thickness of ten feet in which a few fossils were found. The following comprising those that have been identified:—*Strophomena trilobata*, *Rhynchotrema capax* and *Orthoceras anellus*.

Clark Point. This band is again exposed at Clark Point (Limestone Point of Hind) the north-west corner of Sturgeon Bay, in a cliff showing a vertical section of fourteen feet. In the upper part, the beds are a yellowish-gray limestone, with several thin bands of soft clay parting the beds. The stone is soft and easily broken up, showing a good deal of clayey impurity. The section shown is as follows, in descending order:—

| | Feet. | Inches. |
|---|-------|---------|
| Greenish-gray, soft, impure limestone..... | 2 | 6 |
| Seam of light clay..... | 0 | 1 |
| Beds in some places very rotten and easily broken, argillaceous | 2 | 3 |
| Clayey bed..... | 0 | 3 |
| Harder limestone, gray-green, earthy..... | 2 | 10 |
| Shaly band and dark impure limestone..... | 2 | 6 |
| Blue limestone, weathering gray..... | | 4 |
| Bluish-gray limestone, harder than rest of section..... | 4 | 0 |
| | 14 | 9 |

Fossils found in these beds:—*Inocaulis Canadensis*, *Strophomena trilobata*, *Leptena unicastata*, *Maclurea Manitobensis*, *Trochonema umbilicatum*, *Actinoceras Richardsonii*, *A. Python*, *Orthoceras Whiteavesii* and *Trochoceras McCharlesii*. West side
Sturgeon Bay.

Similar beds are exposed at the mouth of the Little Saskatchewan River. That is, the lower beds of the above section are probably found there, but the remaining ones, extending to the foot of the rapids seem to be denuded, leaving perhaps a higher bed exposed there. These seem to be passage beds to the shales of the Stony Mountain formation, and similar ones may perhaps be found along the Red River near Winnipeg. The rocks at Bishops' quarry near St. Andrews are described as being fine-grained, dark-yellow, and are doubtless the lower part of the transition beds, though they suggest very much the rock at the lower part of the section at Carscallen Point.

In the northern part of the lake, the section of the Upper Mottled limestone seen, is of no great thickness, comprising those beds exposed on Selkirk Island and on the points on the mainland northward. Between this and the Silurian at the rapids on the Saskatchewan River, there are no exposures, and the soft beds of the Stony Mountain formation have been denuded, while the possible thickness of this formation is reduced to a very thin section. The mottled beds of Selkirk Island are exposed in several points around the island. The lowest are at the north end. There the exposure shows ten feet of a hard dolomitic limestone, mottled with dark olive-brown spots, the matrix generally a dark yellow. This is in thin or shattered beds which seem to lie about horizontal. The lower beds are richer in fossil remains, but do not hold a great variety. Those identified by Dr. Whiteaves are the following:—*Streptelasma robustum*, *Orthis proavita*, *Rhynchotrema capax*, *Orthodesma affine*, *Maclurea Manitobensis*, and *Actinoceras Richardsonii*. Northern
section.

Selkirk Island

Two miles south, on the western side of the island, limestone is again seen in cliffs showing twelve feet of beds. These are quite thick, but are easily broken up into irregular fragments, in fact the face of the cliff is shattered. Very few fossils seem to be preserved in this rock, which is a hard dolomitic limestone of a yellow colour, with darker stains running through it. The darker parts are much harder than the light, and the surfaces of beds or fractures are in consequence lumpy. These beds are again seen in cliffs a mile and a half farther south. Near the south end of the island flat beds occur near the water's edge. They are somewhat harder and finer-grained than the last, and of a dark orange colour—where polished they are dark

Inches.

6

1

3

3

10

6

4

0

9

reddish yellow. The top surface is planed by glacial action, and a few fine striae are observed bearing south. On the eastern side of the southern end of the island broken cliffs continue to abreast of Horse-shoe Island, on which is also an exposure. These show about twelve feet of a hard dolomitic limestone similar to the upper part of the exposure at the north end of the island. The fossils are badly preserved, and no new species are added to those enumerated above.

Robinson
Point.

On the mainland, these beds are seen in several exposures, running from a point west of the north end of Selkirk Island (Robinson Point) to Howell Point, near the Eagle Islands. At Robinson Point nearly twenty feet is shown. The upper beds are thick, measuring 4 feet 3 inches and 5 feet 6 inches, then in the lower part—ten feet—what appear to have been thick beds are very much broken up into thinner layers. Passing northward the beds rise slightly, bringing up lower beds which are of a finer grain, and as before noted, approach the characters seen in the Cat Head rocks and resemble very much those on Outer Sturgeon Island.

Fossils.

A large collection of fossils was made at Robinson Point, and those identified by Dr. Whiteaves were of the following species:—*Pasceolus gregarius*, *Halysites catenularia* var. *gracilis*, *Streplelasma robustum*, *Dinobolus parvus*, *Strophomena trilobata*, *Leptæna uncostata*, *Orthis subquadrata*, *O. proavita*, *Rhynchotrema capax*, *Tetranota bidorsata*, *Pleurotomaria Stokesiana*, *Maclurea Manitobensis*, *Subulites*, *Actinoceras Richardsonii*, and *Asaphus gigas*.

Sturgeon-gill
River.

A few miles north at a point to the south of the mouth of Sturgeon-gill River, Mr. Tyrrell measured several sections. The beds are similar to those of Robinson Point, with the addition below of beds resembling the cherty beds of Cat Head. The first section is in the bay at the mouth of the above stream, and shows an exposure as follows:—

Section.

'Cliff showing thirty-two feet of cream-coloured limestone similar to that farther south, but more even in grain and without fucoid impressions on the weathered surface. It contains a considerable number of impressions of salt crystals, and also some fossils, though they are very difficult to get out. They are chiefly *Favosites*, *Zaphrentis* and large beaded *Orthoceratites*. At the edge of the water is a bed of very hard, compact and moderately thin-bedded limestone, very much broken and breaking with a porcellaneous fracture.'

At the outer end of the same point the cliffs are thirty-five feet in height, consisting of the following descending section as measured by Mr. Tyrrell :—

| | Feet. | Inches. |
|--|-------|---------|
| Thick and evenly bedded, even-grained, yellow dolomitic limestone..... | 28 | 0 |
| Thin band holding considerable quantities of pyrite..... | | |
| Thin bedded limestone, generally hard, but with many pits or impressions of salt crystals..... | 4 | 0 |
| Yellow, porous, thick-bedded limestone..... | 2 | 0 |
| Moderately thin-bedded, blue clayey-limestone..... | 1 | 0 |
| | 35 | 0 |

'On the slabs on the beach are impressions of the same fossils as before. Some pieces of rock were found holding nodules of flint possibly from the pyrite band.'

At Howell Point the cliff is not so high, but shows a bed three feet below those given in the above section. Mr. Tyrrell's section is as follows :—

| | Feet. | Inches. |
|---|-------|---------|
| Horizontal, cream-coloured, dolomitic limestone, containing <i>Orthoceras Richardsonii</i> and a large <i>Gyroceras</i> | 10 | 0 |
| Apparently unconformably underlying this is a very porous or vesicular yellow limestone, with some impressions of salt crystals, and containing in its lower portion great numbers of concretions of flint..... | 5 | 0 |
| Conformably below this is a blue, compact limestone and a light-gray, hard, evenly-bedded limestone with porcellaneous fracture..... | 1 | 4 |
| Covered by debris..... | 3 | 0 |
| At the edge of the water is hard blue, argillaceous limestone in places slightly brecciated or a conglomerate. In places it is evenly bedded and in others it is in little clayey domes..... | 1 | 0 |
| | 20 | 4 |

In the bottom of the bay to the north the cliffs are also seen and the following notes are extracted regarding them :—

'The rocks are dipping slightly to the south, and coming southward the following descending section is seen :—

| | | |
|--|---|---|
| Evenly-bedded, cream-coloured limestone, such as we have seen before..... | 4 | 0 |
| Yellow vesicular limestone containing a large number of impressions of salt crystals, nodules of flint and a few fossils..... | 4 | 0 |
| Blue, often shaly and probably arenaceous limestone, which in places becomes a moderately fine conglomerate. This conglomerate is occasionally quite sandy in little pockets and strips. It varies somewhat in thickness, the surface of the hard limestone below it, being quite irregular..... | 1 | 6 |

| | | | |
|---------------|--|----|---|
| Howell Point. | Light-yellow, hard porcellaneous limestone, almost horizontal, but lightly undulating. Its surface is very much cut by cracks running in every direction. Generally it breaks in thin resonant slabs. It is divided by several bands of blue shaly limestone that are probably slightly arenaceous and often contain little bands of conglomerate from the water up. It contains a few nodules of flint..... | 10 | 6 |
| | | 20 | 0 |

These sections show that probably the entire thickness of the Upper Mottled limestones as shown at the exposures of Selkirk Island and Howell Point, is much thinner than farther south. The Cat Head beds are also seen at the base of these northern cliffs.

In the topographical descriptions of the different divisions no references are made to the Trenton rocks of Lake St. Martin basin. The only fossils found so far are indefinite, as they include impressions of parts of a brachiopod having sculpture resembling *Strophomena alternata* and a cup-shaped coral, undetermined. These are not sufficiently typical of any of the subdivisions of the Cambro-Silurian to admit of their being placed in any definite horizon.

Stony Mountain formation.

The only natural exposures of rocks referable to this formation are confined to Stony Mountain and Little Stony Mountain. At the former place, the upper limestones are exposed on the face of the hill, but in digging a well for the provincial penitentiary, situated on the south-west spur of the ridge, a section of one hundred and ten feet was exposed. The record published by Prof. Pantou for this section is as follows :—*

| | | |
|----------------------------|--|-------|
| Penitentiary well-section. | | Feet. |
| | Solid, hard stone, like that at the quarries..... | 20 |
| | Thin layers of the same | 4 |
| | Solid rock | 2 |
| | Thin and broken..... | 6 |
| | Yellowish rock, quite ochreous..... | 8 |
| | Reddish layer full of fossil shells..... | 10 |
| | A mixture of yellow and red containing some flinty material..... | 60 |

A general description and section of the surface outcrops on the western face of the escarpment is given from Mr. Tyrrell's notes for 1897, and is as follows :—

‘Stony Mountain rises as a conspicuous rounded hill, sixty feet above the surrounding grassy plain. On its summit is a gravel plain

*.Transaction No. 15, Man. Hist. and Sc. Soc., Winnipeg, 1884.



J. B. Tyrrell, Photo.

LIMESTONE CLIFFS NORTH OF HOWELL POINT, LAKE WINNIPEG.

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or ridge, beneath which is a thick band of bedded limestone, below this again is light-gray, yellowish and red, argillaceous limestone of Hudson River age [Stony Mountain formation]. Toward the west, between it and the ridge extending south from Stonewall, is a wide drift-filled valley. The face of the cliff is very steep even below the drift, as Mr. Gunn sank a well forty-two feet close to the foot of the cliff without coming to rock. The top surface of the hill, in plan, resembles a great horse-shoe opening to the south, and its summit is everywhere composed of flat-lying limestone which is usually yellow and more or less riddled with cavities. It is usually yellowish in colour, but occasionally has reddish streaks, and on the eastern arm of the shoe it seems to be rather thinner bedded than on the western. In places the rock seems to be streaked with many impressions of plants.

'The following is a descending section seen in Mr. Gunn's quarry:—

| | Feet. | Inches. | |
|---|-------|---------|--------------------|
| Bed of gravel..... | 2 | 6 | Section in quarry. |
| In some places this is replaced by a thin coating of boulder-clay. | | | |
| A yellowish-gray limestone in which are some bands mottled with red..... | 6 | 6 | |
| It has a few cavities and fossil <i>Beatricias</i> are fairly abundant. On the exposed surface it is lying in horizontal beds two to four inches in thickness and these beds have not been used for dimension stone. | | | |
| A similar grayish-yellow limestone, some bands being mottled with reddish or brown spots..... | 9 | 5 | |
| Limestone, for the most part in porous, horizontal layers. There are one or two reddish bands which are usually more compact and clayey than the rest, though they are a good, durable stone. Some of these beds are cut for dimension stone. | | | |
| Thick-bedded, yellowish-gray argillaceous limestone, mottled with red blotches. It is softer than the higher limestone, but is said to harden as it dries. The well was bored eighty-six feet from the top of this band.... | 3 | 6 | |
| Soft, greenish-gray, very argillaceous limestone with some bands that are very red and mottled..... | 3 | 4 | |
| Covered, but probably composed of soft, yellowish-green, shaly beds, for little patches of yellowish fossiliferous beds can be seen in places..... | 5 | 5 | |
| Red, highly fossiliferous shale, with many thin bands of limestone from one to three inches in thickness..... | 10 | 8 | |
| | 38 | 10 | |

'This section is carried down to the spur of the railway track, said to be sixteen feet above the level of the main track out on the prairie beyond.

'The well referred to above was drilled in the quarry, beginning 15 feet 11 inches below the top of the rock in the above section, and was quarry.

18
20
22
25

1.0

Well-sections. carried down eighty-six feet through soft, chiefly reddish limestone, probably clayey, to a band of hard limestone from which a supply of water was obtained.'

The characters of the various beds change somewhat, as will be seen by a comparison of the two sections. The surface beds at the penitentiary, appear to be slightly higher than those of the quarry, while the limestone bed yielding water at the bottom of the two wells is possibly the same. The upward extension of the section to the exposed Silurian rocks of Stonewall is found only in well-sections at that place, and shows that probably the top of the Stony Mountain formation is the bed exposed on the surface of the hill at the quarry. The succeeding bed, a white limestone very similar to the Stonewall rock, contains a large per cent of silica or sand, and is probably the basal bed of the upper series. The character of the lime burned from the rock at the two localities is a convenient local distinction. Stonewall lime is very white, while that made at Stony Mountain is much darker and yellowish. The Silurian rocks above the Stony Mountain section are given in the following combined section from wells in Stonewall examined by Mr. Tyrrell in 1897 :

Silurian rocks

Rutherford's well—

| Section between Stonewall and Stony Mountain. | Rutherford's well— | |
|---|--|-----------|
| | Feet. | Inches. |
| | Thick and moderately regularly bedded white limestone, similar to the beds in the quarry..... | 8 6 |
| | Irregularly bedded, brittle, white limestone, broken by numerous fractures and with many small cavities..... | 8 3 |
| | Red or pinkish argillaceous limestone, rather irregularly bedded, though some of the beds are quite thick..... | 14 0 |

Lusted well—

| | Lusted well— | |
|--|--|-----------|
| | Feet. | Inches. |
| | Fine-grained, white, rather clayey, brittle limestone, slightly greenish toward the top, usually rather thick-bedded, but in places thinly or irregularly bedded, silicious..... | 8 6 |
| | Gray, thick-bedded, rough breaking, limestone in which are many holes left by the dissolving away of salt or the decay of fossils. This is apparently the same bed that is quarried at Stony Mountain..... | 6 0 |
| | | 45 3 |

Little Stony Mountain.

Little Stony Mountain was visited by Mr. Tyrrell, and his description and section of it is given below :—

'This is a low ridge running north-and-south and wooded with small poplar on its western side, making it seem higher than it is. There are two quarries, one owned by the city of Winnipeg, and the other by Mr. Egan. In the former some excellent dimension stone and stone for foundations is obtained, and a large amount is also crushed for

street paving. It is opened for one hundred yards in length, and about half as wide, on the eastern side of the ridge. In Mr. Egan's quarry, a short distance farther south, the thick beds appear to have an addition

Diagram of sections.

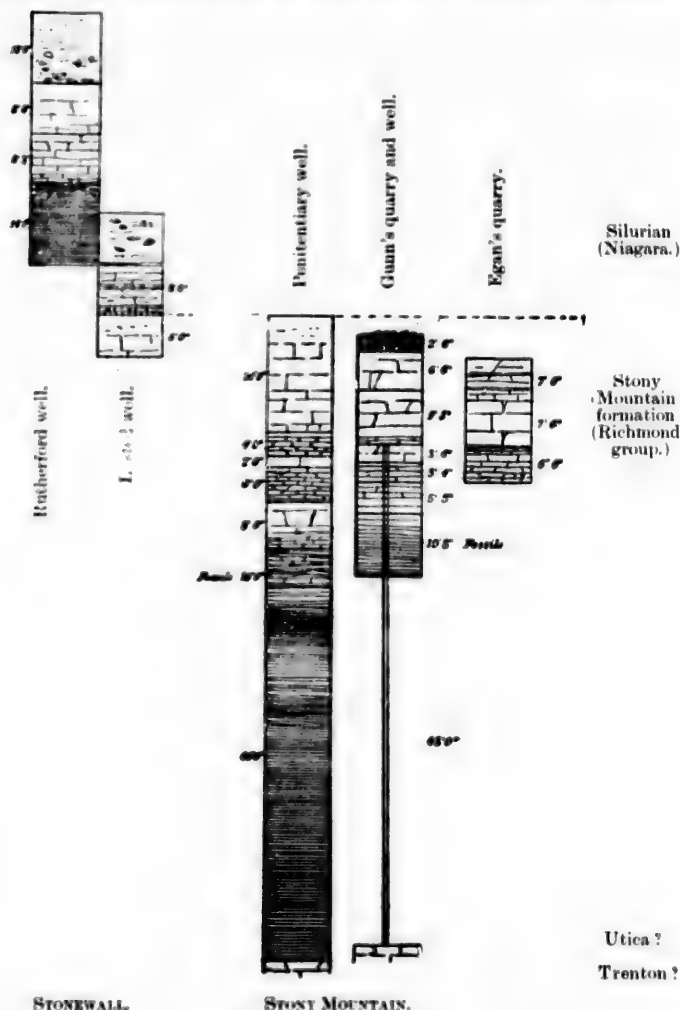


DIAGRAM SHOWING COMPARATIVE SECTIONS AT STONEWALL, STONY MOUNTAIN AND LITTLE STONY MOUNTAIN.

Little Stony Mountain. of one or two feet. The section observed is as follows in descending order:—

| | | | |
|---------------|---|----|---|
| Egan's quarry | Unevenly bedded more or less argillaceous limestone, the beds often having shaly partings or being very much broken. At the top is a bed nearly two feet thick, pretty uniform in texture and granular..... | 7 | 0 |
| | Moderately thick-bedded, hard, whitish limestone, many of the beds riddled with cavities. These are the beds worked in the quarries and the only fossil found so far is a large <i>Beatricea</i> | 7 | 6 |
| | Light greenish-gray argillaceous limestone, thick or thin-bedded, varying to shaly. It shows a number of impressions of fossils..... | 6 | 0 |
| | | 20 | 6 |

Winnipeg. Under the city of Winnipeg, red impure limestones and shales are reached in boring for wells. Near the eastern part of the city the surface of the underlying rock slopes very abruptly to the east, showing that probably these red beds represent the surface of a bed of limestone which is broken down near the river, forming a steep step. The average depth given for the surface of the rock is about sixty feet under most of the city, but at Point Douglas it is increased to one hundred and twelve feet.* The western bank of the Red River at this locality may be taken to be the eastern limit of the Stony Mountain formation.

Rosenfeld. In the southern part of the province no exposures are found, but in the Rosenfeld well-section* there seems to be a great thickness, amounting to one hundred and ninety feet of shaly beds and limestones (Nos. 12-13), situated just above three hundred and five feet of limestone (No. 14) representing the Trenton of Lake Winnipeg.

Distribution northward. Toward the north, this formation evidently thins out very much, and sections of it are not seen on either the Little Saskatchewan River or between the Silurian at the Grand Rapids of the Saskatchewan and the Trenton rocks of Selkirk Island. If there were a series of shales and limestones amounting to a few feet only, exposures might not be expected, and there seems little probability that the bulk of the section as represented in the south, occurs in this locality. The dip of the beds is light and to the south-west and it is probable that the Silurian here overlaps the thin edge of the Stony Mountain formation, the eastern edge of which, might be described as following a line from near Winnipeg north-westerly, skirting the west side of Lake St. Martin,

* See Footsteps of time in the Red River Valley by A. McCharles. Transaction No. 27, Man. Hist. and Sc. Soc., Winnipeg, 1887.

* On certain borings in Manitoba and the North-west Territories by Dr. G. M. Dawson, Trans. Royal Soc. of Canada, vol. IV., part IV., 1886.

and thence north probably altogether beneath the Silurian except at the localities above described. Some doubtful beds near the mouth of the War-path River and at Shiel Point have already been referred to, but the absence of fossils prevents any definite correlation being made, although they resemble some of the beds at Stony Mountain and are above the Trenton rocks of Carscallen Point to the south and Dancing Point to the north. Shiel Point.

The fossils so far recorded from these beds, have been compiled by Dr. J. F. Whiteaves, and published in vol. III., part II. Palaeozoic Fossils (Geological Survey of Canada) and are incorporated in the list of fossils given in the present report. Fossils.

SUPERFICIAL DEPOSITS.

Boulder-clay or Till.

The mantle of boulder-clay which in southern Manitoba seems to be of a maximum thickness of nearly one hundred feet, is found to be much lighter in the northward extension of the basin, and toward the eastern side, on the high land from Grindstone Point to Dog Head, a slight covering only, is found. Very few sections are seen, and the presence of boulder-clay is inferred in many places from the contour of the surface. The high ridge forming Long Point, is connected to the ridge separating Cedar Lake from Lake Winnipegosis, which is believed to be a great moraine. Sections are found on the south side of Long Point, showing light-coloured clay with few boulders. One or two large boulders are exposed, however, in the bank, embedded in a fine clay containing few pebbles. North of the point, the surface is found to be ridged in the direction of the glacial movement and the general description of the shore from the Saskatchewan River to Long Point suggests the possibility of these being of the nature of drumlins. A section of one of these, near the Saskatchewan River, shows a light-coloured clay with numerous pebbles, and many large boulders of light-coloured limestone, all well striated. South of the Long Point ridge, a mantle of reassorted boulder-clay is found covering any boulder-clay which may exist there. This mantle appears, however, to have been of slight thickness, as ridges similar in outline to those on the north side of Long Point are found in many places. Boulder-clay
Long Point.

Glacial Striae.

Glacial striae. List of striae observed on islands and west shore of Lake Winnipeg:—

| | |
|------------------------------|-----------|
| Selkirk Island..... | S. 1° E. |
| Howell Point..... | S. 2° E. |
| Dancing Point..... | S. 35° E. |
| Shiel Point..... | S. 35° E. |
| Berens Island..... | S. 40° W. |
| Jack Head Island..... | S. 25° W. |
| Snake Island..... | S. 25° W. |
| Black Bear Island..... | S. 47° W. |
| Little Grindstone Point..... | S. 42° W. |

In the above list the first four records are from localities on the western side of the lake, and were doubtless made by the southward-moving Keewatin glacier. The remainder are from localities nearer the eastern shore, and were made by the later glacier that advanced from the north-east.

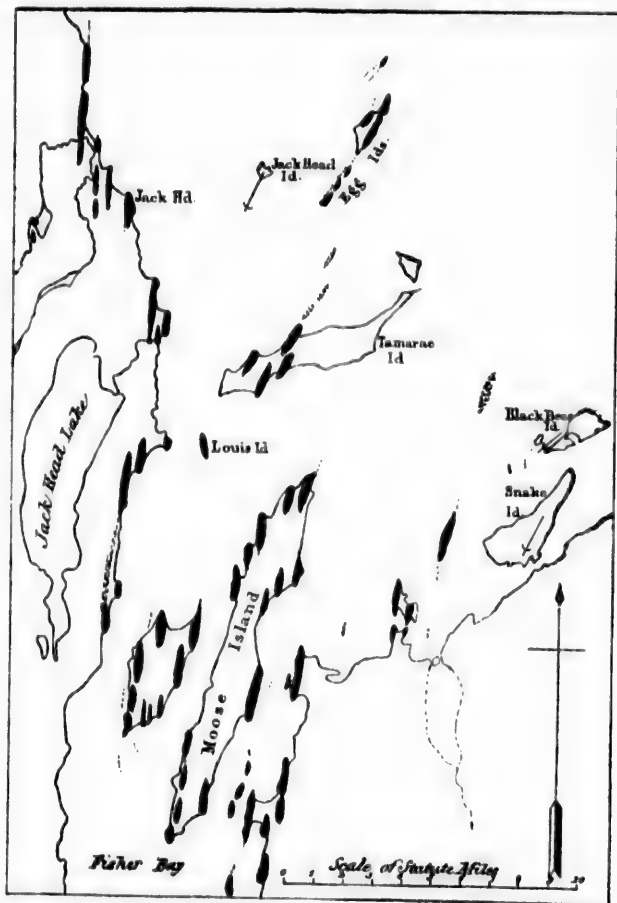
Drumlins.

Drumlins.

Although the surfaces of the ridges of this character observed appear to have been slightly modified by a thin covering of stratified material, their basal composition and form have a direct connection with the direction of the glacial movement. Those noticed to the south of Long Point are briefly the following:—The group of ridges found on Reindeer Island, particularly on the south shore, and the accompanying ones forming the greater part of the St. Martin Islands; the group in the centre of Sturgeon Bay forming the Sturgeon Islands, and also the two large islands called the Inner Sturgeon Islands. To this we may add several lying south of Berens Island as well as those illustrated in the accompanying sketch. To the east and north from Cat Head a string of islands running about S. 35° W. from the eastern side of Berens Island is paralleled by a ridge on the western side of Commissioner Island. These seem to lie parallel to the glacial striae, which were observed on the north side of Berens Island to run S. 40° W. Several of these might be overridden lateral moraines of the earlier glacier, though their origin can not be clearly made out. They are therefore enumerated in the drumlin series.

The next group, at the mouth of Fisher Bay and on islands northward, no doubt contain examples of moraines, but a reference to the map and sketch appended, show that they are intimately related as a whole. The striae found at Snake Island and Jack Head Island bear S. 25° W., and appear to be nearly parallel to the ridges in the vicinity.

Those on Black Bear Island turn more to the west, following the general direction of the shore at that point. If the basin afforded more examples of striae to the south-west of the points above noted, it



SKETCH OF PART OF LAKE WINNIPEG, TO SHOW INFLUENCE OF DRUMLIN RIDGES ON CONTOUR OF BEACH-LINE AND THEIR RELATION TO GENERAL DIRECTION OF GLACIATION.

might reasonably be expected that they would show a deflection toward the south and into Fisher Bay, following also the west shore. This, it will be noted, is the course followed by the ridges, and the

relation between these and the glacial striae is thus apparently maintained.

Fisher Bay to
Jack Head.

In the area shown on the sketch-map, the basin is very shallow and the land is not much elevated above the lake; indeed a rise of fifteen feet in the lake-level would submerge nearly all the islands west of Snake Island and enlarge the width of Fisher Bay. Slight ridges are thus easily distinguished on such a low plane, and are found to have an important influence in shaping the contour of the shore-line. This is noted especially on Tamarack Island and on the shore of the eastern entrance to Fisher Bay. Looking from Snake Island north-westward, the only trees seen on Tamarack Island are those on the ridges, the tamarack swamp forming the remainder of the island being below the line of sight. Moose Island, properly speaking, is one long ridge, but the lesser ones forming the points are noticeable. Eastward, owing to the low country, the ridges marked above, appear from a distance as a group of islands.

Reassorted Boulder-clay.

Reassorted
boulder-clay.

Exposures of this deposit are not numerous, those noted being mainly on the west shore. The ridge described as occurring near Jack Head River is composed partly of reassorted material, but the section of it on the lake-shore shows only about three feet. The stratification is indistinct, but the material was evidently deposited in water. The clay is of the boulder-clay type, and is plentifully supplied with both large and small boulders of gneiss and limestone.

On Fisher River, the deposit is of a more pronounced stratified type with fewer boulders; and farther south, near Gimli, cut-banks on the shore show a decidedly stratified clay.

Stratified Sands and Gravels.

Stratified
sands and
gravels.

On the south side of the eastern end of Long Point, a low exposure of coarse stratified sand is found. This is a deposit of later age than the clays forming the point, and undoubtedly overlies them. The group of islands lying to the eastward in the centre of the lake, George and Sandy islands, are composed of stratified gravels and sands forming small plateaus. The middle one of the Sandy Islands is the largest, and shows the best section of the gravel terrace on its southern side. The highest point of this appears to be about fifty-five feet above the lake.

George Island is the next in size, and the section is there very similar to that of the first. In both, the highest part of the deposit is on the south-west side, and the surface of the terrace slopes from this point slightly toward the north-east. The sections exposed show clearly the stratified nature of the terrace, but those on the face of the higher accumulation are not so definite. It seems probable that the higher parts represent the remains of esker deposits flanked by the reassorted material in the form of small plateaus. This is suggested in part, by the fact that these islands are arranged in a broken line running from near Poplar Point on the east side out in a north-westerly direction toward the end of Long Point.

Stratified
sands and
gravels.

The higher portions of the smaller islands are liberally sprinkled by large Archean boulders, evidently carried there by floating ice during a higher stage of the lake, shortly after this deposition of material, and while the plateaus were being formed.

Stratified sands very similar in general structure are found near Elk Island on the south shore. Boulders were there noted sliding down the face of the banks, as though falling from the surface. In this connection it may be mentioned that Bird Hill, east of the Red River, north-east of St. Boniface, presents somewhat similar deposits.

Lake beaches.

The formation of a beach commences primarily by the accumulation of the heavier debris left by the denudation of the shore. This may form a boulder-ridge, grading down to a gravel- or sand-bar, as the result of the denudation of boulder-clay, or bars of a more uniform composition if derived from exposed cliffs of stratified rocks. Later on, however, the transporting action of the waves, effects a change in their composition, boulder pavements being covered by gravel of a totally different origin, or by sand from an adjacent point. On Lake Winnipeg the transported beaches particularly noticeable are those of limestone gravel from the cliffs of Trenton limestone exposed on the lake.

Beaches.

Boulder beaches or pavements.—These may be classed under two heads, corresponding with the origin of those found on the lake. On the western side, in the shallower parts, the ridges described as being of the nature of drumlins in contour, are found to have remarkably rough bouldery shores, especially at the northerly and southerly extremities, often forming long bars extending out in the lake. The boulders seem to be derived from the boulder-clay forming the points of the ridges. They are thus left in place while the finer material is

Boulder
beaches from
boulder-clay.

**Boulder
beaches.**

assorted and spread over the bottom of the lake. This action is particularly noticeable on the western shore. The boulders derived from boulder-clay forming the string of islands running south from the east side of Berens Island form pavements and bars that are good examples. Plunkett Island, on which the lighthouse is placed, is surrounded by so rough a wall of boulders that a landing place for small boats can hardly be found, except at an artificial slip in front of the keeper's house.

From terraces.

Another system of boulder ridges is found on the islands in the large open part of the lake—Sandy and George islands. These being formed of easily eroded material have had their sands and gravels distributed around their margins, but falling from the surface in some places down the steep banks, are numerous large boulders which remain and form a wall. The south side of George and Little George islands are good examples. There the boulders are of nearly uniform size, though occasionally large. All are of Archean gneiss, schist or granite. Sandy Islands also have the same boulder beach-ridge derived from the erratics deposited on the surface of the gravel terrace.

**Gravel
beaches.**

Gravel beaches.—These are either of similar origin to the boulder beaches or are derived from denudation of cliffs of rock. Owing to their being composed of smaller material, which is more easily transported, they are often found at a distance from the original deposit from which they are derived. Sand beaches also are sometimes found in the vicinity of exposures of sand or of the soft sandstones of the south-eastern portion of the lake.

**Limestone
gravel.**

Limestone gravel beaches.—The denudation of the limestone cliffs affords abundant material at many points, and this is often found to be spread at quite a distance from the parent cliff. In the narrower portions of the lake from Dog Head south, the transportation has not proceeded far and the bars so formed are generally near the cliffs. These are sometimes useful, inasmuch as in a few cases they form small hooks, running out sufficiently far from points to form sheltered harbours for small craft, in places where there is a lack of such accommodation. At the north-western end of the Grindstone Point cliff, at Anderson harbour, a strong hook or continuation of the gravel-ridge of the shore projected into a small bay, forms a well sheltered nook. Another of the same nature is found on the point across the bay west of Bull Head at what is locally known as Boucher Point.

On Black Bear Island, the cliff at the east side affords material that has been carried along the south shore almost to the mouth of the

steamboat harbour. On its westward course this bar has already inclosed a small bay near the east end, and from low exposures of limestone near the harbour, about the centre of the south side, material is being carried into the mouth of the harbour, narrowing its entrance, and if the supply were adequate and the water not too deep, might close up the mouth.



BLACK BEAR ISLAND.

DÉBRIS FROM LIMESTONE CLIFF FORMING BAR ACROSS A BAY.

Transported bars are found on the south-east and north-west points of Little Tamarack Island, forming small hooks. At Inmost Island the smaller material, gravel and sand, from the rock exposures on the north side, are distributed in a long bar, nearly connecting this island to the mainland to the south. Transported bars.

Between Cat Head and McBeth Point, which seems to have been the end of an island, is now found a high bar of limestone gravel derived from the adjacent cliffs. This is the heaviest accumulation of its character on the lake. The Little Black Island cliffs are supplying material to form bars, running eastward to connect with Berens Island, and on the east side of Berens Island there are also examples of transported gravel bars,—one of them, ending in a small bay, forms a little harbour which was used in former times by the trading company's brigade of boats, as a rendezvous for those going west by the Little Saskatchewan River.

Transported bars are also found tailing out from several of the islands at the mouth of Sturgeon Bay and on the St. Martin Islands. Examples are also found on the west shore, north of the mouth of the Saskatchewan River, and in many cases, form small harbours. The

Transported
bars.

last examples to be cited are those on Selkirk Island and the small island off the south-east corner. The harbour at the north end is formed by a heavy gravel-bar running west from the north point, then turning to follow the shore southward for half a mile. This, thus forms a long narrow bay, deep enough for lake steamers and well sheltered. Deep water is found up to the edge of the bar on the inside and the harbour has been used by the fishing companies. Another, made in the same way, is that on Pony Island, already described as forming a horse-shoe by two bars running from both sides of the island to the westward.

Gravel and
sand-beaches.

Gravel and sand beaches.—The bay at the north-west corner of the lake called Limestone Bay, is protected by a long narrow spit of sand. This may be wholly transported from the eastward, as the result of storms from the south and east in the fall. The long north shore reaching to the outlet of the lake having mostly a sand beach, would afford a large supply of material for the bar. South of Long Point the corner inclosed between it and the west shore, is being cut off by gravel- and sand-bars built from both shores, and numerous smaller examples of this, are found along the north side of the point, where many bays are already cut off. A heavy sand- and gravel-bar is found uniting two islands off Saskatchewan Point in the same manner as McBeth Point is now united to Cat Head, while near by in Lynx Bay a heavy sand-bar cuts off a portion of the end of the bay, which is now formed into a lake.

Further examples are seen at Sandy Bar, north of the mouth of Berens River and in the long bar stretching westward from Berens Island toward Little Black Island, inclosing in an angle, a shallow bay used by fishing companies and known as Swampy Harbour.

In the southern part of the lake, examples may be cited in the bars stretching west from Big Island, and a companion bar from the west shore near Icelandic River. Willow Point is also mostly built up by transported material. The small bluffs on the east end are on slightly higher ground—possibly a former island, which is now connected to the mainland by bars formed from material carried south from the vicinity of Gimli. Across the lake at Grand Marais and near Elk Island other similar examples are indicated on the accompanying map. The beaches along the south shore are partly transported and partly derived from the sifting of the delta material brought down by the Red River. The transporting agent is generally the waves, and as the direction of the storms affecting this part is mostly from the northward, the transportation effected is from both the east and west shores, converging to the centre of the bay.

